JUN 1 8 1947

SAE JOURNAL

June 1947

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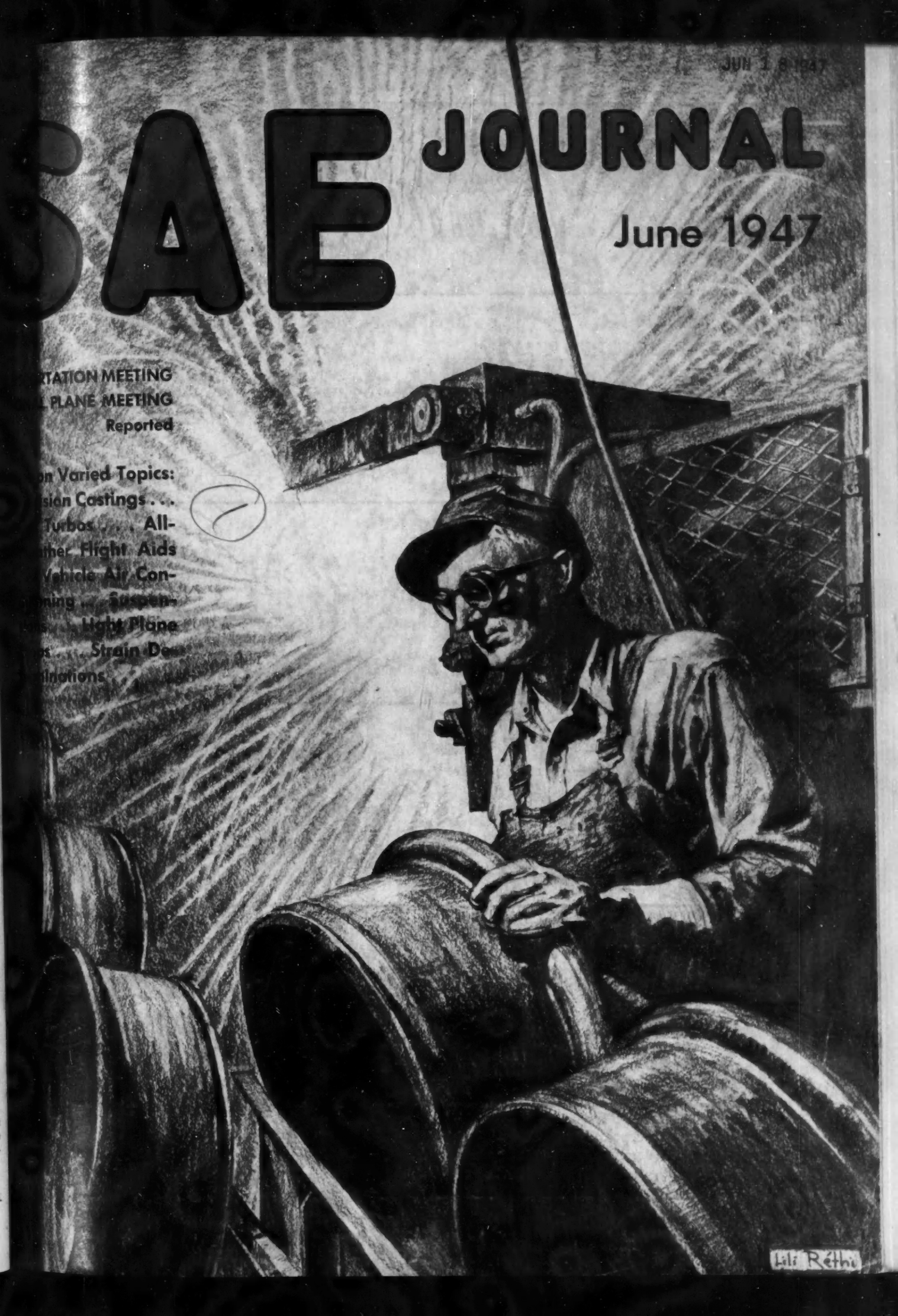


Rumor Page

IT'S RUMORED THAT

cars may soon have a lifetime paint job!

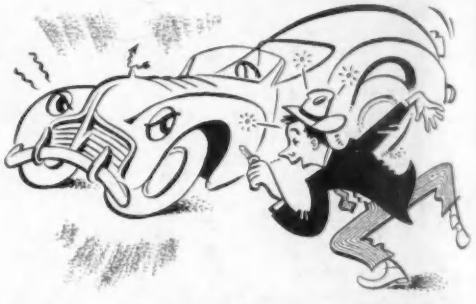
According to General Electric, a silicone paint they now have in the development stage may within five years offer cars a lifetime paint job. Tests show that the special paint is highly resistant to severe weather conditions, chemicals and heat and it is expected to offer brighter, clearer colors.

IT'S RUMORED THAT

the '48 cars will have a device that makes the brakes get tight when the driver does!

We think this one, Mr. Rubick, tops the alcohol-sensitized car key that hops out and hides itself at the smell of liquor on the driver's breath. Thanks for pointing up the fact that drinking and driving don't mix.

Contributed by Kenneth A. Rubick, Lamar, Colorado



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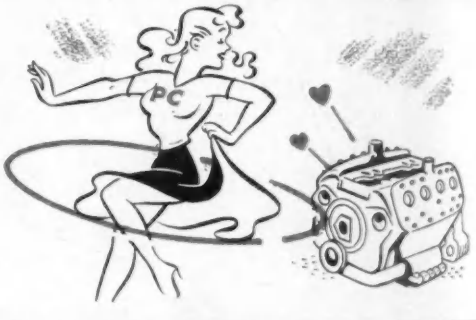
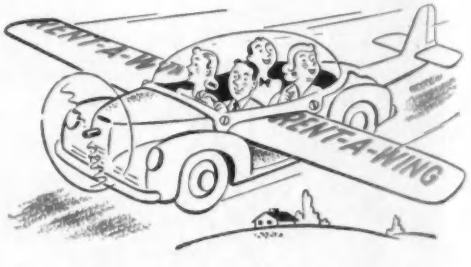


IT'S RUMORED THAT

one of America's largest plane manufacturers is developing a 4-place auto-plane with interchangeable detachable wings!

What's more, it's rumored that rent-a-wing service would be available at all major airports, making it possible to take the highway or skyway at any time, any place. However, this is a rumor and further details are not available.



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The Cover

● Newest automotive wheel development is the wide base rim, a development described before several SAE Section meetings in recent months. Our front cover shows the new rims rolling along the production lines for new vehicles and change-over at Firestone Steel Products Co.

For the Sake of Argument

By NORMAN G. SHIDLE

The difference between a boss and a leader is not always discernible to the naked eye. Each is best distinguished by the fruits of his efforts.

The boss gets mediocre results from good talents; does his best work with docile, unimaginative assistants. The leader translates a maximum of each person's ability into useful service.

Boss and leader wear the same clothes, have the same title on their doors, belong to the same clubs, smoke the same brand of tobacco. But if you watch them operate for a while, you will notice special habits forming an envelope of action and happiness around everybody who works for the leader.

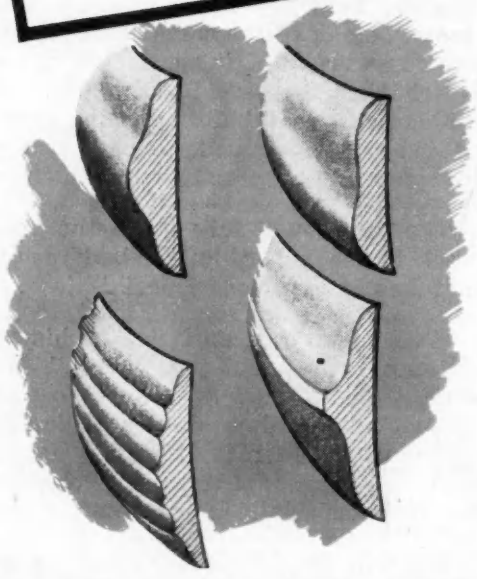
The leader will talk about the good work of his subordinates; bad results he takes as his own responsibilities. . . .

He is found constantly telling his assistants "why" – not just "what." His subordinates, who never have to execute an order without understanding its significance, generate increasing interest in their tasks; steadily are prepared for advancement.

You will find the leader insisting on promotion from within whenever possible; constantly seeking new incentives for his groups. . . . Somehow he manages to give each individual a feeling of dignity and pride about his own job.

These are just a few of the signs. The longer you have been in business, the easier it is to read them.

LIGHT, STRONG BUMPERS "BY THE MILE"



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New Student Development . . . .

I am happy to report a striking new development in the Society's student program. By authority of the SAE Council it is now possible for SAE Enrolled Students to progress from student affiliation with the Society to regular SAE membership without payment of the $10 initiation fee normally required of new SAE Junior Members. Here is how it works:

During the period he is in college, the engineering student pays a fee of $3 per year for the privileges of SAE Student Enrollment. When he leaves college he is entitled to a post-collegiate year of SAE Enrollment for a fee of $5 if he is working in industry, $3 if he is in the armed forces. If he applies for regular SAE membership prior to the completion of this extra year of SAE Enrollment and is elected to Junior grade of membership, payment of the normal $10 initiation fee will be waived. An Enrolled Student who is elected to Junior membership may request that his membership become effective before the completion of this post-collegiate year providing he has had at least one full year of SAE Student Enrollment.

We hope and expect this special provision for SAE Enrolled Students will enable increasing numbers of engineering students to continue affiliation with SAE through the transition from collegiate to professional life. One of the more important byproducts, we are confident, will be greater coordination between the SAE activities of the Society's Sections and SAE programs at engineering colleges. There is no better connecting link between industry and campus than the young engineer who is familiar with both.

Richard B. Smeed

Chairman, General Student Committee

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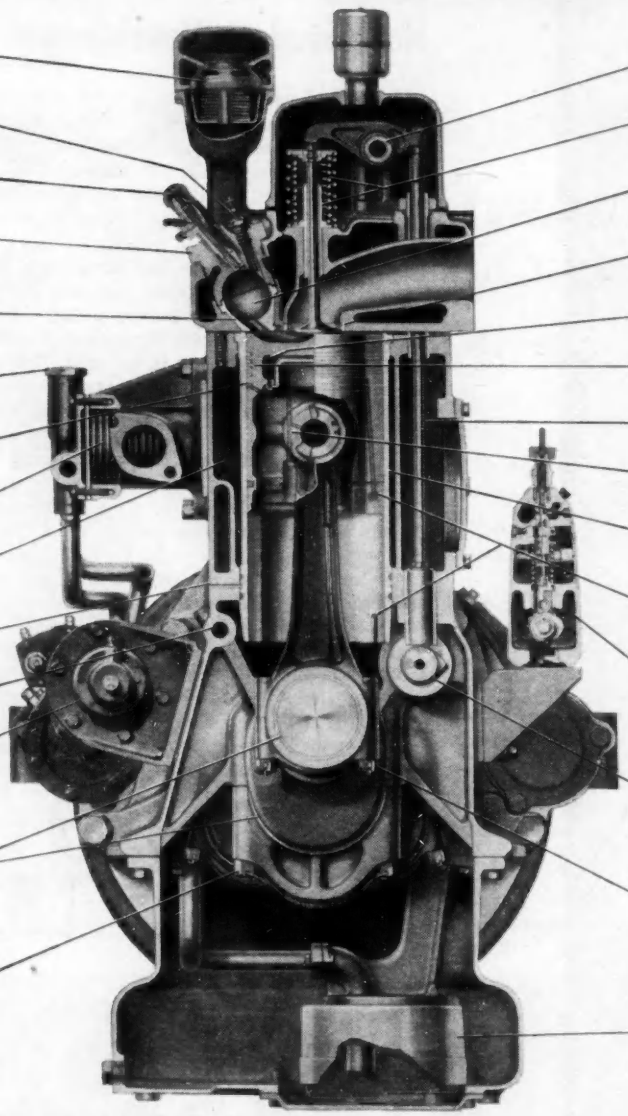

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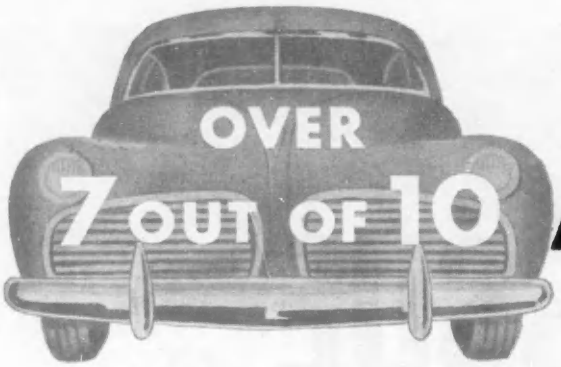

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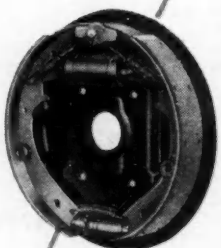

Experience is the reservoir of precedent that holds many of the answers to problems of the future, and makes it possible to avoid errors of the past. The most promising plan can go astray in one tiny error that experience would have forestalled. And in the automotive field—where experience is the keystone of success—Bendix* can point to thirty years' cooperation with a progressive industry.

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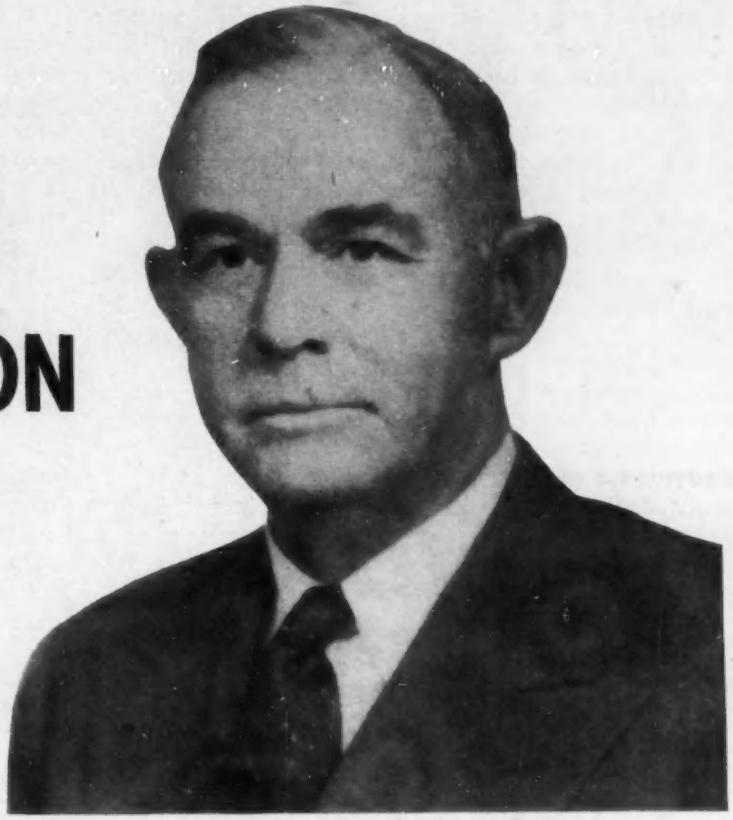
NEED NATIONAL POLICY TO HALT AERO INDUSTRY'S DISINTEGRATION



EXCERPTS FROM A PAPER* BY

Major-Gen. Oliver P. Echols, U. S. Army (Ret.)
President, Aircraft Industries Association of America, Inc.

DESPITE the United Nations Organization's genuine effort to arrive at understanding and cooperation, the present gap between the ideal and the actual is much too broad for us to feel secure. UNO is an organization for world peace based on strength, not weakness.

Article 45 of the UN charter says: "to enable the United Nations to take urgent military measures, members shall hold immediately available national air force contingents, for combined international enforcement action."

Russia, still the great unknown, has publicly admitted large military expenditures. Much of it will undoubtedly be for air armament to be produced with the aid of German scientists. In an expansive and an aggressive mood, she failed to carry out her agreement made at Potsdam, has looted and refuses to evacuate her troops from Manchuria, has refused to keep her commitments in regard to a free and independent Korea.

She stands alone against the eleven nations endeavoring to come to a reparations settlement with Japan, leaving that country's economy chaotic. Chaos is a fertile field for Communism.

China's civil war seems as far from settlement as ever, Europe is boiling with its old animosities, and the British Empire is breaking up before our eyes. In Greece and Turkey, Britain is forced to curtail sharply her once stabilizing role of global policeman, and is shifting the burden to us.

Every citizen, and certainly a group of leaders such as make up the SAE, should be gravely concerned with the subject of air power's role in the maintenance of world peace.

Are we taking the steps to maintain a "decent air force" as specified by General Eisenhower?

* Paper "Maintenance of Peace Through Air Power," was presented at SAE National Aeronautic Meeting, New York City, April 11, 1947.

Are our air force contingents to be truly "immediately available" as the UN charter requires?

Most Americans are not aware that our once most powerful Air Force in the world is a formidable air power at our present rate of disintegration.

Today, world military authorities recognize that air power consists of a modern, up-to-date Air Force-in-being backed by a healthy air transportation system capable of fulfilling its tremendous role in the logistics of the wars of the future, and the nucleus of an air industry. This industry must be strong in research and development and of such size as to be capable of the rapid expansion necessary to meet the high levels of production which are required by the Mobilization Plan.

To sustain the Air Forces-in-being there should be a regular annual production of the latest types and models of air weapons required to keep this Air Force modern. Experience has proven that the second best Air Force is little better than none. Never again will Britain, France and our other allies hold back the enemy while we are building the best Air Force. The fulfillment of these requirements of modern Air Power grows increasingly difficult, and it is becoming increasingly expensive. Since our Air Power is disintegrating we must decide whether we are going to pay the premiums on our national defense insurance policy, or are we going to let it lapse? We must decide quickly. If we let it lapse, a new policy will cost real money next time – assuming fate should be kind enough to let us buy another one.

Research and development cost money, and maintenance of the nucleus of an industry also costs considerable money as compared with our prewar standards. However, the annual appropriations would be very small compared to our expenditures for aircraft in the recent war.

Twenty years ago, one man could design a modern fighter all by himself. In his head alone was stored all the engineering and design knowledge required to build that 200-miles-per-hour plane. Just six man-months of engineering time was required.

Today, design of a 600-miles-per-hour warplane will require the services of at least 200 to 300 engineering specialists, including experts in more than a dozen different specialties of aeronautical science. Thousands of hours of engineering will be expended before the first test flight is made. and many times those thousands of hours will be required after that test flight to incorporate design changes found necessary during operational tests.

The engineering job in aeronautics is growing at an incredible rate. One company has reported that its 1946 jet fighter required five times as much engineering effort to develop as did its fighter of 1940.

Another company translates these soaring engineering requirements into dollars of cost:

During the past 12 years its cost for designing and developing a prototype aircraft increased from $24 to $224 a pound – a tenfold increase. Yet, this company says that the cost for a prototype jet aircraft will be $400 a pound, or 20 times the cost of only a dozen years earlier.

Factors responsible for this perpendicular rise in engineering costs are:

1. Revolutionary scientific developments in instrumentation and propulsion have radically altered all previous concepts of performance and missions for conventional aircraft, pilotless missiles, and other radical innovations. New jet fighters travel just twice as fast as the fighter of 1938 – more than 600 mph compared with 325 mph nine years ago. The AAF's new superbomber can carry a bomb load for short ranges actually greater than the weight fully loaded of the famous B-17. This new bomber's range with a bomb load of approximately 10 tons is truly world-wide.
2. Economic trends of wages, and
3. Increased material costs.

Aeronautical research, development, and engineering problems are ever growing more complex. Instruments, wings, fuselages, configurations and propulsion are undergoing vast changes. Jet and rocket propulsion have captured the public imagination, but few people seem to realize that jet and rocket engines are in a state of development which will require much money and time to make them satisfactory. Atomic energy for propulsion is being explored by aeronautical scientists and aircraft companies.

Panels Resemble Consoles

Instruments are changing so rapidly that no pilot will recognize the cockpit after a few years' absence from flying. Jet planes are smaller, yet they must carry more radio and radar than the aircraft of a few years ago. Conventional instruments – such as automatic pilots, turn and bank indicators – have greatly increased engineering assignments compared to a few years ago, and the automatic instrument landing equipment now under development will further increase installation problems.

Aerodynamically and structurally, air foils are undergoing a revolution and are piling up a formidable engineering task. New wings are so thin that entirely new methods of construction are being developed, and new alloys and materials are evolving. Yet, these new structures must withstand greater strains and pressures, because these new wings work against compressibility in the sonic ranges.

Then, to further complicate the picture, the thin wings are forcing the redesign of landing gear, because conventional types cannot be retracted into thin wings. Their thinness also necessitates the redesign of fuel tanks, and other components. Flying wings, swept-back wings, diamond-shaped wings must be investigated and perfected.

We hear much about pushbutton warfare. Here, too, is a vast assignment for aeronautical engineers. Gen. George Kenney recently said that the first successful flying missile with a 5000 mile range will probably cost *billions* of dollars. It will require years of engineering. Structures will require an entirely new alloy able to withstand the frictions at staggering speeds. Fuels and powerplants must be perfected.

Directional control, free from static interference, is of itself an almost unimaginable scientific and engineering challenge.

At the peak of our war effort, 19 major aircraft companies employed some 11,900 skilled and experienced engineers. Following the cutbacks in production after the war, aircraft companies reduced total employment from the peak of more than 2,000,000 to less than 200,000 – a *drop* of over 90%. Yet engineering staffs of some of the companies are *above* the wartime peak. This is another measure of our research and engineering task.

Recently a number of aircraft manufacturers have been forced to begin to lay off skilled and trained engineers, and others are losing their engineers to industries engaged in production of non-aviation products. At a time when the aircraft industry is faced with the most challenging and perplexing engineering problems ever known, this is a paradox that must be studied.

This paradox's answer is found in the lack of American air policy, and the consequent effects upon the aircraft industry. From the victory-winning output of 96,000 airplanes in 1944, production plummeted to a total of only 1330 military and 467 transport aircraft in 1946. This dribble of combat and transport planes actually was smaller than the 1939 total of approximately 2500 units.

The small production in 1946 resulted in 7 of the 11 largest airframe companies reporting losses in 1946. Only tax carrybacks prevented the other four companies from ending up with losses. The existence of this situation is not generally known, since the high earnings reported by the majority of American industries has apparently led to the assumption that all industries shared in last year's prosperity.

A recent National City Bank of New York report shows that earnings in the aircraft industry declined by 95% from 1945 to 1946, in sharp contrast with the increase of 36% over the 1945 level shown for all 1500 manufacturing corporations combined. The aircraft industry's earnings decline was by far sharper than that reported for any other industry in that tabulation.

Clearly, such financial conditions do not encourage companies to embark upon the costly and baffling research projects that need to be undertaken.

It is difficult to justify outlays for preserving intact the teams of engineering specialists required to cope with modern aeronautical problems under such circumstances.

Almost 18 months ago, the Air Coordinating Committee, the official agency designated by the president to coordinate aviation within the Federal agencies, and to recommend air policy, completed a study of aircraft demobilization problems. That committee concluded that for the purpose of national security the United States should maintain a comprehensive aeronautical research and development program and a nucleus of an aircraft industry producing a minimum annual output of 3000 military aircraft, plus a sizeable total of commercial and personal airplanes. This minimum output of 3000 planes a year was held to be adequate, the committee said, "After maintenance of world peace was well assured and a substantial degree of disarmament had taken place." If the need was for a substantial striking force ready at all times to cooperate in the maintenance of world peace, then, the Air Coordinating Committee stated, we should have an industry producing 5740 military aircraft, plus a special quantity of commercial and personal planes.

Obsolescence Seen

A few months later, the Special Senate Committee to investigate the National Defense Program, (the Truman-Mead-Brewster committee) warned:

"The aircraft industry must continue to produce combat airplanes on a scale adequate to maintain constantly a well-trained, properly-balanced, experienced staff of workers and technicians who can keep abreast of the most improved and efficient aircraft manufacturing techniques and produce the latest types of combat aircraft. Otherwise, our peacetime air arm will soon become outmoded and obsolete."

This same report of the Truman-Mead-Brewster committee emphasized as did the Air Coordinating Committee that an aircraft industry needed to preserve our air power cannot exist on civil business alone. The Senate committee observed on this score.

"Although many of the manufacturing techniques and production methods used in the civil aircraft industry can be adapted to the production of military aircraft, the planning, design and actual manufacturing of military aircraft constitutes a separate function."

While the functions are different, there is reason to hope that eventually the manufacture of civil aircraft will contribute importantly to the preservation and support of the enormous engineering staffs required to overcome the challenges I have cited.

The industry now has on order from American and foreign airlines some 854 new two- and four-engine transports. They will add approximately 45,000 seats to world capacity, and in addition

these planes will operate at speeds 50% greater than those now in service, which will further augment capacity. Our own airlines operated 800 planes with around 24,000 seats at the year-end, and load factors were then around 68% or 70% of capacity. We now begin to perceive that the commercial airline market will be filled for some years to come when present orders are delivered during 1947 and early next year.

When current models grow obsolete 5 to 10 years from now, and when surplus planes wear out, the situation will be different. Then, civil production can carry a large portion of the load of maintaining the requisite organizations of engineers and manufacturing specialists.

But what will happen during the next 5 to 10 years?

The development which will probably obsolete current new models of transports will be the perfection of jet transports and completely weatherproof navigation and traffic control equipment. It is estimated that the first successful jet transport will require 8 to 10,000,000 man-hours of engineering, and may cost $20,000,000 or more. Who can afford to pay for this development? Airlines are in the red, too, just as are the manufacturers.

Some aircraft companies are laying off engineers, others are turning to the production of other products such as trucks, plastics, and motorcycles. If this is to be our national policy, if we are to ignore the challenge of aeronautical science, then we should say so as a matter of policy and our aircraft engineers and manufacturers can concentrate on other pursuits.

If this should *not* be our policy, then it is time Congress enacted a sound policy and halted the tendency to drift and to ignore the official and Congressional warnings I have cited.

Continuity Needed

Perhaps the most difficult problem to be solved by a national air policy is to provide some continuity in the industry's work load. The problem of time is particularly serious, because design and development of successful aircraft may require five, and even seven or eight years. As we are now entering totally unexplored fields in many branches of aeronautical science, the time factor is even more forbidding.

Under such circumstances it is simply not possible for an engineering and development organization to undertake to explore a new field of science and to perfect devices, instruments, and applications that are now in their infancy unless it is possible to foresee a consistent program of support for such development. If the prospect is for lavish support in short-lived periods of emergency, and then an abrupt termination of such support in periods of peacetime, the chances that the requisite number of engineering, development, and manufacturing facilities will be maintained are small indeed.

The need is *not* for a huge volume of, or a large, work load. But our national air policy must be firmly established by law and provide for a continuous program of research development, and manufacture. Only then can the enterprise in this industry make definite plans and determine with some accuracy the size and character of the engineering and development organizations they can maintain.

Lag Is Costly, Dangerous

An abrupt termination of engineering work and a resulting lull of a year or so naturally sets an organization or a nation just that far back in the development cycle. The lag resulting from such terminations can only be overcome in emergencies by the expenditure of enormous sums of money with accompanying **great waste.**

During World War I, while our allies held the front, we built up an aircraft industry and an air force, which was allowed to die from lack of national policy and support. In the 19 years from 1922 to 1940 inclusive $555,000,000 were appropriated to the U. S. Air Forces for the procurement of aircraft. In the years 1941-1945 inclusive these Air Forces expended $48,000,000,000 for the procurement of aircraft. It took four years of the most intensive effort for the production rate to meet requirements. This includes the one and one-half years prior to Pearl Harbor while our allies delayed enemy advances. We can never again have time to rebuild our industry. If there is another war, we will be the initial target. We are repeating the same mistakes we made after World War I. Had we been even reasonably strong and accepted our responsibilities, there probably would have been no World War II.

If we become weak and defenseless we are likely to become involved in another war. If we are reasonably strong, we have a reasonable chance of carrying out these responsibilities and maintaining the peace.

Congress should act promptly to establish a firm and comprehensive national air policy. This policy should be established only after an exhaustive investigation has been completed of all phases of air power. Once a national policy has been determined, Congress should establish an agency charged with its implementation and the duty of submitting an annual report to the public and the national legislature, showing exactly to what degree our national policy is being implemented.

With such action, the nation could feel secure, knowing that the air arm was being maintained in sufficient strength to make a potential aggressor loath to attack us. Then we would feel confident that challenges of aeronautical science, with their potentially immense social and economic benefits, would be fully met.

DESIGNERS, USERS SEEK ACCORD

S. A. Jeffries, SAE vice-president for Truck & Bus (left), and SAE Vice-President D. K. Wilson of the T & M activity (right), flanking Robert L. Biggers who spoke on "Wartime Experience Pays Transportation Dividends" at the National Transportation Meeting dinner

President C. E. Frudden (left) chats with Chicago Section officers at the SAE National Transportation Meeting April 16 to 18 at Chicago's Stevens Hotel. Seated with Frudden is W. H. Oldacre, chairman of the Section which acted as host, and standing are O. A. Brouer, T & M vice-chairman (left) and Russell H. Johnson, the Section's Truck & Bus vice-chairman

LOWER maintenance costs through accessibility, use of synthetic lubricants, new forms of vehicle suspensions, and sound deadening were focal points of the SAE National Transportation Meeting, April 16 to 18, in Chicago's Stevens Hotel.

The meeting was sponsored jointly by the Transportation & Maintenance and the Truck & Bus Engineering Activities of the Society, and the 684 representatives of America's giant motor transportation industry, who came from 36 different cities from coast to coast and border to border to attend its technical sessions, were quick to realize the mutual benefits which combined SAE forums offer both the manufacturer and operator through frank exchanges of differences of viewpoint on design, operation and maintenance.

Great credit is due the officers of both Activities who conceived the idea of bringing together the designers and users of trucks and buses.

Almost 500 who sat down to dinner in the Grand Ballroom heard SAE President C. E. Frudden pay a tribute to the late Henry Ford – and heard Robert L. Biggers, president of Fargo Motor Corp. (division of Chrysler Corp.), talk on "Wartime Experience Pays Transportation Dividends." This was followed by his own colored movie "Operation Sleepless" taken aboard Admiral Marc Mitschner's flagship during a carrier fleet maneuver in the Caribbean Sea in 1946, and illustrating the individual effort plus teamwork which made aircraft carrier operations successful.

President Frudden hailed the National Transportation Meeting as a prime example of the practical application of joint cooperation in the solving of mutual problems of truck and bus design and maintenance and service operating costs.

Frudden spoke reverently of Henry Ford as one of the founders of the Society, whose membership application was number two, and who in the second year of the Society read a paper titled "Simplicity."

Biggers, who was introduced by Co-Toastmaster O. A. Brouer, characterized both maintenance and truck and bus engineers as "experts." He hailed their wartime accomplishments and said they have merited the admiration and gratitude of the entire country.

"No set rule or mass-production formula can accomplish a Reconversion of Thinking," said Biggers. "It will not come about through the

change in multitudes, but through the collective sincerity and the influence of individuals – a lot of little fellows.

"Great social and political advancement has always been accomplished that way."

Sessions Are Lively

Spotlight of attention throughout the meeting was focused on first cost of equipment, increasing operating costs, and a search for ways and means of reducing the operating cost per ton-mile for trucks and per passenger-mile for buses, through less frequent servicing.

Sessions provoking the most informative and controversial discussions were "Elimination of Causes of Frequent Servicing"; "Torsional Suspension for Trucks and Buses"; and "A Practical Approach to Satisfactory Acoustical Design of Automotive Trucks."

T. L. Preble, Tide Water Associated Oil Co., presenting the operator's viewpoint of the basic subject of "Elimination of Causes of Frequent Servicing," called inaccessibility the greatest contributing factor to the high cost of servicing, and warned that low-cost highway transportation is jeopardized by expensive and frequent servicing.

He invited designers and manufacturers of commercial vehicles to take advantage of findings available from the gigantic national proving ground created by vehicle operation and maintenance. Design-for-maintenance, based on these findings, would help commercial operators to combat the great increase in maintenance costs. Labor alone has gone up 200%.

Lubrication requires far too much time and should be shortened and simplified, he said. Broad overall maintenance reports show that the average maintenance time for the average vehicle was 39.8 hr in 1942 as against 32.5 hr in 1930, with labor costs $55.72 as compared with $26.00.

Maintenance people cannot be expected to be contortionists or acrobats, he added, remarking that parts or adjustments which need regular attention should be placed where they can be reached. All these troubles, Preble said, originate in design. For this reason, truck and bus users would like to contribute to design and manufacture from the experience data they have developed in the operating fleets of the country – comprising approximately 1,000,000 trucks and more than 100,000 buses. Further maintenance economies must be designed and built into commercial vehicles at the factory.

Speaking from the manufacturer's point of view, D. B. Erminger of International Harvester Co. held that elimination or decrease of service frequency is a secondary consideration in the minds of most vehicle buyers. When faced with paying an extra premium for longer-wearing parts and units, or for service-eliminating innovations, the buying public as a whole, he said, will cheerfully forego prospective service advantages in favor of lower initial cost.

He pointed to extended training programs for the better instruction of mechanics, better tools, factory reconditioning, and rebuilding of replacement units as steps toward reducing rising maintenance costs. He stressed the great progress that has been made in metallurgy, chemistry, design and engineering to improve steel, oil, rubber, and other products.

Conflicting viewpoints were raised in discussion between what was claimed by manufacturers' advertising departments and what the operators actually want. Operators denied they want a lot of sheet metal for better looks – all they want is accessibility, several declared.

Torsional Pros and Cons

Torsional rubber and torsion bar suspensions to replace leaf springs was vigorously debated by proponents of both systems at the April 17 afternoon session on "Torsional Suspension for Trucks and Buses."

N. E. Bateson, F. R. Fageol and Col. J. M. Colby, strong advocates of torsional suspension, held out for more comfortable riding, better balance, less noise, more space for payload and other beneficial characteristics.

A group of important truck and bus executives and engineers who attended and participated in the SAE National Transportation Meeting included, left to right: Roy E. Cole, vice-president of Studebaker Corp.; L. Ray Buckendale, past-president of SAE and vice-president of Timken-Detroit Axle Co.; Frank R. Fageol, president, Twin Coach Co.; L. H. Smith, president, General American Aerocoach Co.; C. A. Peirce, vice-president and chief engineer of Diamond T Motor Car Co., and F. S. Baster, vice-president and chief engineer, White Motor Co.

B. Frank Jones, Truck & Bus Meetings Committee chairman (left), with H. L. Willett, Jr., T & M Meetings Committee chairman, who were largely responsible for the excellent program of technical papers presented at the meeting

Fageol, chairman of Twin Coach Co., advocated the use of torsional rubber suspension systems, such as were developed for military vehicles, particularly for heavy vehicles. He insisted that this design cannot produce squeaks or rattles, assures a more comfortable ride regardless of load, has better balance, better roadability, less roll and sway, greater passenger comfort, greater protection from shock to the vehicle, longer life and less maintenance cost, than other types of springing.

The paper presented by Bateson, of the General American Aerocoach Co., covered the detail of torsion bar design with supporting formulas to prove the claim of a more comfortable ride as well as the reduction of unsprung weight of the vehicle.

Stability of the vehicle and resistance to both vertical and side shocks as well as the favorable effect of steering geometry to produce less oversteering and understeering was discussed. A life expectancy of 200,000 miles has been designed into torsion bar springs, he said.

Colonel Colby, head of Ordnance development, Detroit Arsenal, laid great claims for the value of torsion bar suspension as applied to the huge tanks used in the last war. Torsion bar suspension, he said, reduces battlefield and road shocks to tank crews to a minimum, increases the stability of the firing platform, permits more effective grouser action and enables vehicles to negotiate higher obstacles.

He also pointed to the decrease in unsprung weight, and greater shock absorbing capacity when applied to wheeled cargo carriers, resulting in greater speed, more comfort to the crew, and greater stability.

Advocates of leaf spring designs jumped into this discussion in a hurry.

Murray Fahnestock said it seemed like only yesterday that Fageol was defending with equal enthusiasm the merits of steel torsion bar suspensions. He was skeptical of costly experiments by bus manufacturers and said that the operators have to live with them for the next ten years.

Rubber ages, he said, and therefore will not last forever. He claimed that Fageol ignored the fact that modern buses are equipped with "progressive" or variable-rate springs, which can be designed for any desired variation in rate.

Walter F. Whiteman, chief engineer of William & Harvey Rowland, Inc., referred to the variable-rate leaf springs that have been used by passenger cars, which he claimed give the finest ride empty or loaded of any car made. He said that two- or three-stage leaf springs will attain any ride with proper deflection, if bus engineers will make the proper changes in shock absorbing and provision of space to contain these two- and three-stage springs.

A prepared discussion by A. S. Krotz and L. C. Lindblom of B. F. Goodrich Co. corroborated Bateson's statements, especially those dealing with unsprung weight.

In the open discussion L. H. Smith, president of General American Aerocoach Co., disagreed with Fageol's conclusion that rubber is impervious to grease and is the only means of eliminating shackles. He also criticized a statement made by another engineer that no fleets are using rubber shackles, since he knew of several that are 100% so equipped.

He countered Whiteman's leaf spring claims and said that leaf springs do not give the necessary baggage space, as torsion bars do.

Spokesman for the Leaf Spring Institute, N. E. Hendrickson, refused to accept Bateson's statement that a torsion bar weighs ⅛ as much as a leaf spring. He also objected to the statement that the main leaves of springs hold up only because of rubber bushings. He knew of no spring eye breakages in Greyhound buses, which have threaded steel bushings. Rubber bushings are not necessary, he feels.

Ralph Cress of Chevrolet Motor Division directed the attention of designers to the uncomfortable ride experienced in the tractors of tractor-trailer combinations. Since the two vehicles of the combination have opposite spring rates, the tractor and trailer fight each other, he said. He cited other factors – balance, for one. His experience with that type of vehicle on the Burma Road proved that 4-wheeler units which were converted into 6-wheelers using the same springs gave greatly improved riding comfort.

Speaking on the subject of "A Practical Approach to Satisfactory Acoustical Design of Automotive Trucks," B. G. Radin delivered the paper prepared by himself and Charles Thomas of the Ford Motor Co.

The speaker reminded his listeners that wartime tests had revealed that the skill of pilots decreased with length of exposure to the high noise level in planes, and suggested that some highway

accidents involving trucks might be traced to similar causes.

Session Chairman F. B. Lautzenhiser advocated improved engine mountings, carburetor intake, muffler mounting, cab mounting, steering gear insulation from the frame and propeller shaft insulation.

Dr. Howard C. Hardy, Armour Research Foundation, a specialist in noise abatement, showed by a chart that motor truck sound levels have been reduced by acoustic treatment from 95-100 decibels to about 87. He pointed out that this still leaves a long way to go. This level is still above the speech level. He pointed out that if the decibel level could be brought down another 10-12 points, speech intelligence would double.

J. L. S. Snead, Jr., of Consolidated Freightways, Inc., pointed out that in truck cabs it is impossible for drivers to hear warning signals. He questioned that noise causes fatigue and said that Consolidated's records show that the majority of their accidents occur during the first three hours drivers are on duty.

B. F. Jones, Autocar Co., said that in a recent experiment a cab seat, adjustable in eight directions, had been built to see whether fatigue is a result of sitting in one position. The fatigue level in this seat was the same after 8 hr as it was in a solid seat after 2 hr.

M. C. Horine, Mack Mfg. Corp., suggested that if engineers would endeavor to reduce or eliminate sound at the source through better balance and through design it would not be necessary to insulate vibration. The quality of sound is more important than the quantity or volume, he said.

Synthetic Lubricants

In his paper on "Fleet Tests of the New Synthetic Lubricants," D. K. Wilson, superintendent of automotive equipment, New York Power & Light Corp., characterized synthetic lubricants as satisfactory for heavy-duty, all-weather service, basing his statement on tests with commercial delivery trucks, tractors, compressor trucks, earth-borers, and winch trucks.

Compared with petroleum oils, synthetic lubricants cover a greater range of temperature with a single grade, and reduce carbon formation, Wilson said. At least double the oil mileage is obtained in all classes of service, while starting and operating in cold weather are greatly facilitated.

General discussion brought out the opinion on the part of operators that further tests of synthetic lubricants are needed, however. Other large users who conducted tests include General Baking Corp., Little Falls Laundry and Standard Oil Co. (Ind.).

Carl Georgi, Quaker State Oil Refining Corp., questioned the amount of ash as a satisfactory telltale for the drainage of oil.

In his paper on "Sleeve Bearing Lining Materials," W. E. Thill of Federal-Mogul Corp. reported serious shortages in tin and antimony, which are still under Government control; of cadmium, for which the demand greatly exceeds the supply, and of steel, lead and copper. Thill discussed in considerable detail the various bearing materials and their uses, and tubing and strip bearings, the two principal types.

H. W. Luetkemeyer, chief engineer of Cleveland Graphite Bronze Co., speaking on automotive bearings from the service viewpoint, reported that bearings of reputable manufacture seldom fail from poor metallurgy or dimension quality, but that bearing life is shortened by extreme increases in rated engine output, improper installation, and more severe use of engines in duty that the design permits.

Although E. P. Gohn of Atlantic Refining Co. questioned the value of aluminum bearings, Thill said that they are being used very successfully in certain installations. They are more subject to misalignment, and proper clearances are not easy to obtain. In addition, installations are more difficult to make in the field.

Protective Coatings

"Protective Coatings for Increased Life in Bus and Truck Parts" was presented under three headings: Electroplating, Metal Treatment, and Organic Finishes. Continual pressure is exerted by truck and bus operators on the manufacturers for better protection of parts against corrosion, rust, and so on.

L. J. Schustik, of E. I. duPont de Nemours & Co., Inc., handled the electroplating phase of the subject and called attention to the fact that all protective coatings must satisfy three conditions to be effective, namely: (1) An insoluble coating must be formed; (2) the coating must be adherent, and (3) the coating must be continuous or nonporous.

Of particular importance in determining the adherence of any coating is the preparation of the base metal by thorough cleaning. Porosity and adherence are recognized as the principal factors involved in making electroplated coatings more resistant to corrosion.

In covering the subject of "Metal Treatments Prior to Painting," V. M. Darsey, president of Parker Rust-Proof Co., emphasized the necessity of treating the surfaces of easily corrodible metals and alloys before painting. He recommended that a phosphate coating then be given to improve corrosion resistance and paint adherence.

"Organic Finishes" was presented by Roy B. Davis of E. I. duPont de Nemours & Co., Inc. He emphasized that selection of the finish and proper treatment during application are critical factors. He recommended phosphate coatings for steel parts and sheets and zinc chromate primers for aluminum alloys.

. . . . Design Aims for JET Installations

FROM A PAPER* BY

GAYLORD W. NEWTON

Chief, Power Plant Unit, Boeing Aircraft Co.

PERFORMANCE . . . Reliability . . . Fire protection . . . Accessibility . . . Control . . . These are the fundamental considerations which should govern design of installations for gas turbine powerplants. Reexamination of these fundamentals will lead to more functional design than mere copying of the installation design practices used with reciprocating engines.

These considerations apply to installations of reciprocating engines, but that is about as far as the similarity goes. Familiar problems with cylinder cooling, induction systems, and numerous accessories have disappeared. Some problems have reappeared in different form, and new ones have been added. But all of the problems should be approached from the viewpoint of the fundamental considerations.

1. *Performance:* Basically, the gas turbine is an air-accelerating machine. Its performance can be seriously influenced by the design of the nacelle, cowling, and air intake. All three must be designed to maintain the efficiency of the air cycle.

Obstructions such as the internal cowling over the nose-section accessories and the spinner and afterbody used with a propeller must be aerodynamically clean. When no plenum chamber is included, acceleration of ram air as it approaches the compressor inlet must be gradual in order to avoid losses. This may be difficult with the accessories, drains, and structural members extending into the path of the air.

2. *Reliability:* The reliability of various installation components must increase to keep pace with the lengthening periods between engine overhauls. Reliability is particularly essential in the fuel system because an interruption in flow will stop the turbine. The starting procedure must be repeated before power is resumed, and restarting difficulties grow worse with altitude.

Light vibration loads with gas turbine powerplants encourage construction which will eliminate sources of failure in reciprocating engines. For example, flexible tubing with screw-type end fittings can be used for fluid lines. There will be less plumbing and fewer accessories to fail.

Icing of the air intake ducts is one of the familiar reliability problems. Internal heating can prevent icing of parts which project into the air stream. Icing conditions are more of a problem with axial-flow compressors than with centrifugal compressors. A number of research groups are currently comparing performance benefits and losses resulting from alternate intakes for use when icing conditions prevail.

3. *Fire Protection:* Gas turbines have fewer fire hazards than reciprocating engines. Fuel and lubrication systems are better isolated from sources of ignition, and there are not so many exhaust connections. Compartmentation to isolate hot sections can cure some of the present fire hazards.

If the ventilation path is known and can be controlled, fire detection and extinguishment is simplified. A few detectors strategically located will suffice. With prompt detection, fires go out of their own accord when fuel flow is cut off and excess accumulations drained.

Some units incorporate a shutoff in the oil system for use in case of fire. However, shutting off the lubricating oil may cause serious damage if the powerplant continues to windmill. A brake or an airflow control to prevent windmilling or some form of limited lubrication is worth considering.

4. *Accessibility:* The installation should provide accessibility to parts of the powerplant in order of their need for inspection and their importance. Using the installation as a test stand, it should be possible to make all but major repairs without removing the engine.

Fairly large pieces of cowling give quick access. Their handling is feasible because present airplanes equipped with gas turbines carry maintenance crews of at least two men.

Interdependence of several sections of cowling is a nuisance when only one section needs to be removed. Cowling latches should be positive and

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*Paper "What are the Essential Requirements of a Gas Turbine Installation?" was presented at SAE National Aeronautic Meeting, New York, April 11, 1947.

Unveil Plane Wheel

EXCERPTS FROM A PAPER* BY

Marvin H. Polzin

Wheel and Brake Development
Goodyear Aircraft Corp.

COMBINING dynamic loading in the laboratory with brittle lacquer stress analysis is the quickest method of developing lighter and longer-life airplane wheels and brakes.

Wheel structures in service are subjected to a combination of landing shock, rotational inertia, tire inflation pressure, radial and lateral rolling fatigue, brake torque, and other loads. Anyone trying to decide where and in what direction to apply strain gages to obtain a fairly accurate strain picture without the aid of brittle lacquers eventually ends up in a padded cell. Strain analysis without brittle lacquers is like a library without an index.

To corral the antics of dynamic strains, the strain gage must follow-up brittle lacquer testing.

To clarify the problem of obtaining dynamic Stresscoat patterns, it may be well to review some fundamentals.

The coating cracks under tensile strain only, in a direction perpendicular to the direction of the strain. Although the coating under ideal conditions is brittle enough to crack at 400 microinches per in. strain (equivalent to 12000 psi stress in steel, 4000 psi stress in aluminum, and 2600 psi stress in magnesium), it still has very definite plastic flow properties. The more time involved in applying the strain to the metal under the Stresscoat, the greater the strain in the metal required to crack the coating. The coating creeps or flows toward a relaxed position on the new dimension of the metal under it, the amount of creep being a function of time.

When the metal is under compressive strain, the coating does not crack; but the creep property is still functioning. If the compressive strain in the metal is held long enough, the coating will come to a completely relaxed position, a condition of zero strain. If now the compressive strain in the metal is relaxed to zero strain, the same quantity of tensile strain is imposed on the coating, provided the loading has been within the elastic range and the load is released quickly to eliminate reverse creep in the coating.

If the imposed tensile strain on the coating exceeds its crack sensitivity – the minimum strain required to crack the coating – cracks will be formed perpendicular to the direction of compressive strain in the metal under the coating.

There are always two strains, strain in the coating and strain in the metal, which must be considered separately and distinctly. Sometimes they coincide; sometimes they are opposite. It is the knowledge of the relation between the two which makes the visible Stresscoat cracks intelligible in terms of the invisible strains in the metal.

The strain determination problem is to obtain a Stresscoat pattern exactly at the peak of strain magnitude so that the direction of strain at its maximum value may be determined. A strain gage located in this direction will then indicate the complete strain cycle including the peak value.

Since for the most part a wheel is made up of a number of identical sections, the stress distributions of which may be assumed to be identical, it lends itself to the application of a number of coatings with different sensitivities. The various coatings of Stresscoat are separated by an increment of strain sensitivity of about 0.0001 in. per in. Since the exact first point of full load application can hardly be controlled, it must be assumed that the full load strain cycle may be initiated at any point.

For the sake of illustration, let us assume we have a tensile strain wave of constantly changing direction, that the magnitude varies as in Fig. 1, and that the wave is initiated at its lowest point. Assume also that eight different coatings have been applied to the wheel, with sensitivities in 0.0001 increments from 0.0006 in. per in. to 0.0013 in. per in.

The 0.0006 coating will then have a tension pat-

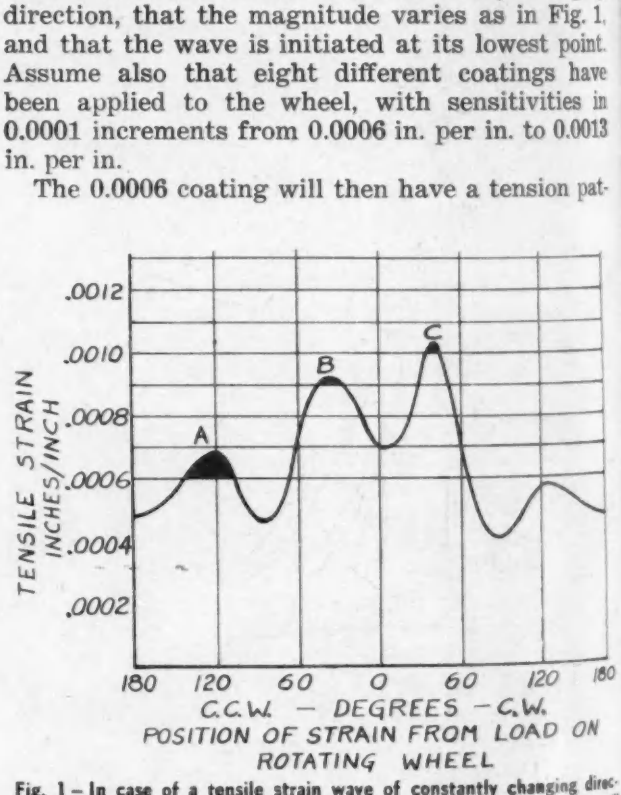

Fig. 1 – In case of a tensile strain wave of constantly changing direction, use of Stresscoat applications of varying strain sensitivity will determine amount and direction of principal tensile changes

*Paper "The Experimental Determination of Strains in Aircraft Landing Wheels and Brakes," was presented at the SAE National Aeronautic Meeting (Spring), on April 9, 1947.

Service Stresses With Laboratory Stresscoat Analysis

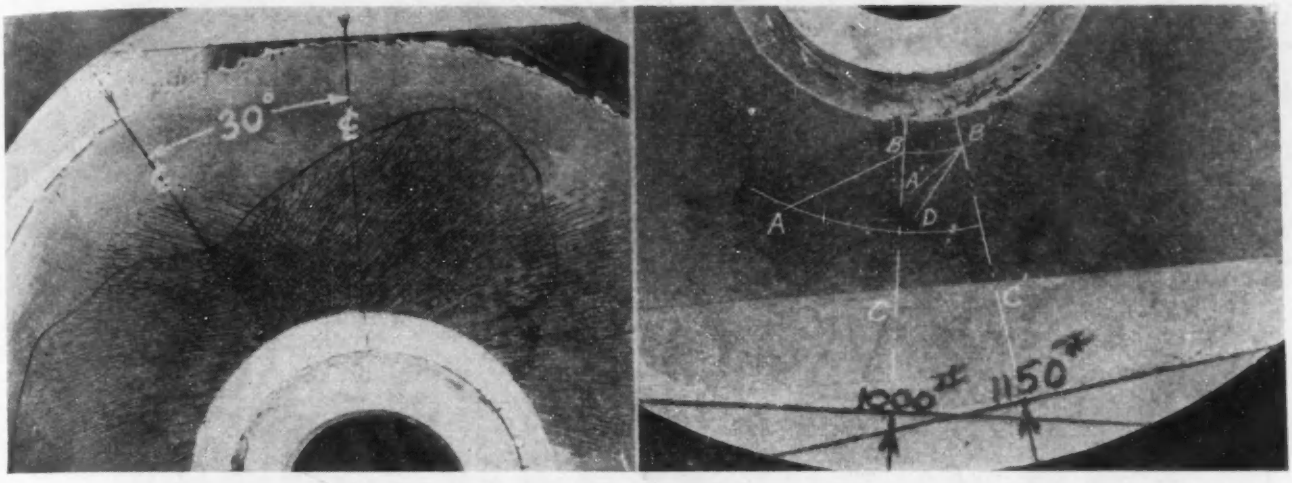

Fig. 2 – This flat disc was subjected to bending loads of 1000 and 1150 lb – at angles of 30 deg in the photograph at left and 15 deg in the one at right – to determine the effect of pattern crossover of two strains on Stresscoat sensitivity

tern initiated by strain A (that portion of the first peak which exceeds 0.0006 in. per in. strain). This pattern may be overlapped by succeeding strains of 0.0006 in. per in. or greater. Likewise the 0.0009 coating will be patterned by strain B, until at the 0.0010 coating a pattern is obtained which will show the direction of the peak magnitude only. Coating 0.0011 will have no pattern since the peak applied strain does not exceed the cracking sensitivity of the coating.

Therefore, regardless of which point on the strain cycle corresponds to the beginning of full load application and regardless of how much the direction of the principal tensile strain changes in one load cycle, its location and direction may be obtained within the increment of strain sensitivity between the applied coatings.

Referring again to Fig. 1, let us suppose that the 0.0009 coating has been patterned by strain B. To what extent will this pattern be crossed by succeeding strain pattern C of slightly greater magnitude and in a different direction?

To obtain a qualitative check, a flat circular disc supported at its center by screwed-together bushings was placed on a vertical axle in the static load machine and a bending load applied along one edge by the hydraulic ram. The disc is shown at the left in Fig. 2, the tape along the edge representing the initial area of contact before any bending took place.

A 1000-lb load was applied to the coated disc

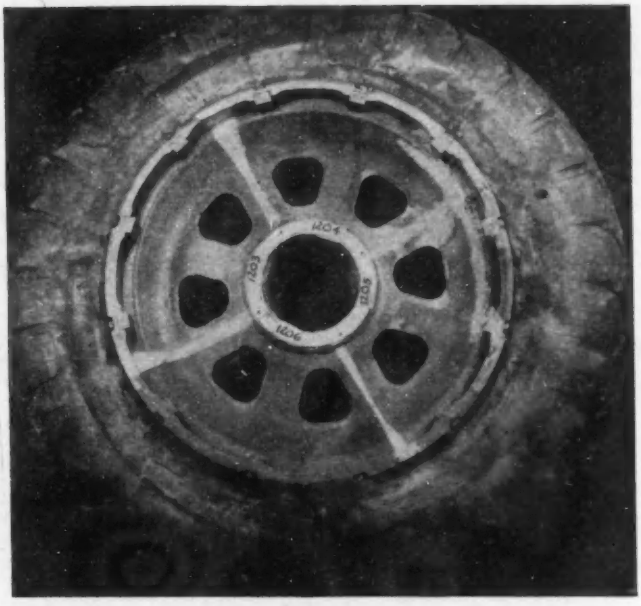

Fig. 3 – Dynamic testing of this wheel resulted in the strain patterns shown. The tire blew out after rolling the wheel for 3 min under a 50% overload of 16,500 lb

and the boundary of the crack pattern contoured by a heavy line. The disc was then rotated counterclockwise 30 deg and a 1150-lb load applied so that one strain pattern crossed the other. Inside the right end of the contour line can be seen limited crossover at low angle (about 10 deg) and at the center of the contoured area the full crossover at right angles.

Note the converging strain patterns in the first loading which blend into curved lines at the load centerline. In the superimposed crossover pattern no such curve exists, even though the actual strain distribution must be assumed to be identical. Instead the particular one of the two converging strain patterns, which holds the optimum crossover angle of 90 deg with respect to the first pattern, extends its pattern beyond the load centerline into the area covered in the first load pattern by its companion strain. This strain is now prevented from occurring by its low angle of crossover on the intensive initial pattern.

The right-hand photograph in Fig. 2 shows the same disc with the same loads applied at an angle spacing of 15 deg. ABC is the angle (about 61 deg) between crack direction and load centerline in the first loading. A′B′C′ represents ABC moved counterclockwise around the disc centerline by 15 deg. If the direction of the first pattern had been duplicated in crossover, A′B′ should be the direction of the crossover cracks.

DB′ making an angle of 47 deg with B′C′, the load centerline, is the actual crack direction. This shows the tendency for a pattern to swing toward a 90 deg crossover at high angles since this presents the least opposition to cracking. Strain gage measurements at point B′ showed a strain of 0.00090 in. per in. perpendicular to A′B′ compared to only 0.00082 in. per in. perpendicular to DB′, the actual crack direction.

After several angles of load shift had been tried, it was concluded that:

1. Right angle crossover is accomplished with practically no loss in sensitivity.

2. Low angle crossover is dependent on (1) the angle, (2) the spacing between cracks of the first pattern at the point in question, and (3) the magnitude of strain of the superimposed crossover pattern.

3. The direction of low angle crossover is reliable, at least to 45 deg.

4. When biaxial strains of similar magnitude act as a crossover pattern, that strain which holds the higher angle of crossover with the existing pattern will predominate, other conditions being equal.

5. Use of several coatings will closely segregate the peak strains in simple rolling of a wheel. But if the rolling is succeeded by combined rolling and braking torque, the combined load patterns will be superimposed on the patterns from rolling load only. In such cases final patterns must be very closely examined since the superimposed or crossover pattern may leave rather meager evidence and yet be more critical than the initial pattern. Further probing by strain gages is necessary to establish the pattern.

Although perhaps less critical, a knowledge of compressive strains is very desirable to complete the dynamic strain picture. The normal procedure for obtaining compressive patterns statically is to hold the maximum load for 3 hr and then to release the load. During the 3 hr, the coating comes to a completely relaxed condition on the shortened dimension of the metal under it so that, upon load release, it is cracked in tension with sensitivity comparable to normal tension loading.

Less sensitivity can be obtained in a matter of a few minutes; but of course dynamically wheel loads at any one point are held only an infinitesimal amount of time.

Dynamic testing is performed on a series of flywheel dynamometers. For a roll test the flywheel

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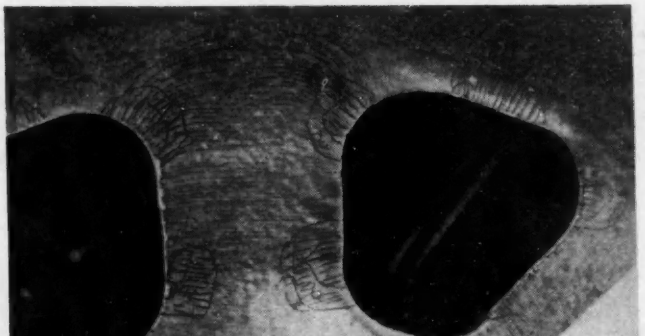


Fig. 4 – The spoke of the wheel in Fig. 3 with the most sensitive coating shows the growth of tension pattern contours with increasing load

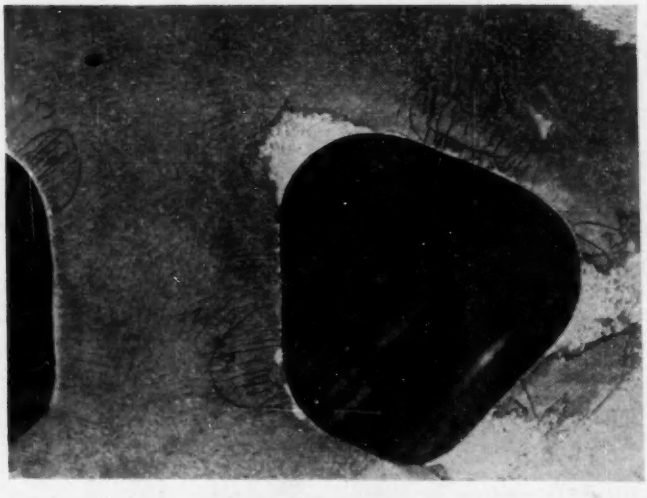


Fig. 5 – The spoke next to the impact spoke developed lengthwise cracks, indicative of compressive strains

LOW COST, SAFETY emphasized at Personal Plane Meeting

ENGINEERING development of aircraft components requiring fewer manhours, or cheaper or less materials, without compromising existing high standards, got major emphasis in papers and discussions at the two-day SAE National Personal Aircraft Meeting at the Hotel Lassen, Wichita, May 1 and 2.

Engineering design is assuming an increasingly heavy responsibility in the critical battle to hold down personal plane prices in the face of rising costs. And the industry is spurred by knowledge that market analysts generally consider existing prices for personal planes already too high to attract a real mass market, and have stated repeatedly that every price increase for personal aircraft will diminish the potential market.

While efforts to simplify design to reduce costs of production are found in most of the personal plane companies, they are also a part of the program of the various propeller, engine and accessory manufacturers, the Wichita speakers indicated.

President C. E. Frudden, in his speech at the dinner, said that the meeting represented a real and tangible contribution of the Society's services to the aeronautical industry.

"We can overlook neither the potential effects nor the byproducts of SAE aeronautical work. These interests of the Society and the security of our nation—perhaps the peace of the world—are mutual and parallel," he said.

"Thus, what you do here, and what you report here, will interest other SAE members whether they be airborne or earthbound in their specific technical tasks."

Total registration neared the 500 mark, and many attended the inspection trip to the Cessna Aircraft Co. plant, where Duane L. Wallace, the company's president, was host; and to Beech Aircraft Co., where its president, John F. Gaty, was host; and to Beoing's Wichita plant, arranged by that Division's chief engineer, H. W. Zipp.

SAE Past-President William B. Stout addressed the dinner audience on "A New Approach to the Flight Problem."

The well-rounded technical program included a broad cross-section of reports on design achievements and developments in personal plane and helicopter fields, which provoked lively controversy in floor discussions and continued in some cases in hotel room debates after the general sessions had ended.

Combination of experimental and production planning to select the most inexpensive method of working materials into finished components, and to eliminate unnecessary parts through new design approaches was strongly advocated.

Typical among examples cited of components redesigned with savings in manhours was a stabilizer which originally required 24 hr 45 min for fabrication, installation and assembly per plane, with $15.45 material cost per plane, 5876 hr of tooling time, 86 parts per plane, and which weighed 27.04 lb per plane.

A newer design of equal high standard produced an equivalent stabilizer in 8 hr 3.92 min fabrication, assembly and installation time, at cost of $11.18 in material, with only 2477 manhours of tooling time, using only 28 parts, and weighing only 20.1 lb. It was pointed out that savings in manhours per plane is the most important factor, since tooling is not repetitive, but the savings of manhours per component multiplied by the number of units produced in a

Members of the Personal Aircraft Program committee, headed by Tom Salter, are shown here. Standing, left to right: George L. Quinn, W. E. Burnham, Virgil W. Hackett, W. H. Roesing, and H. T. Johnson, who served also as chairman of the Reception Committee. Seated, left to right, are M. L. Carter, W. A. Day, and Herb Rawdon

year's production represents an important factor in the overall production cost.

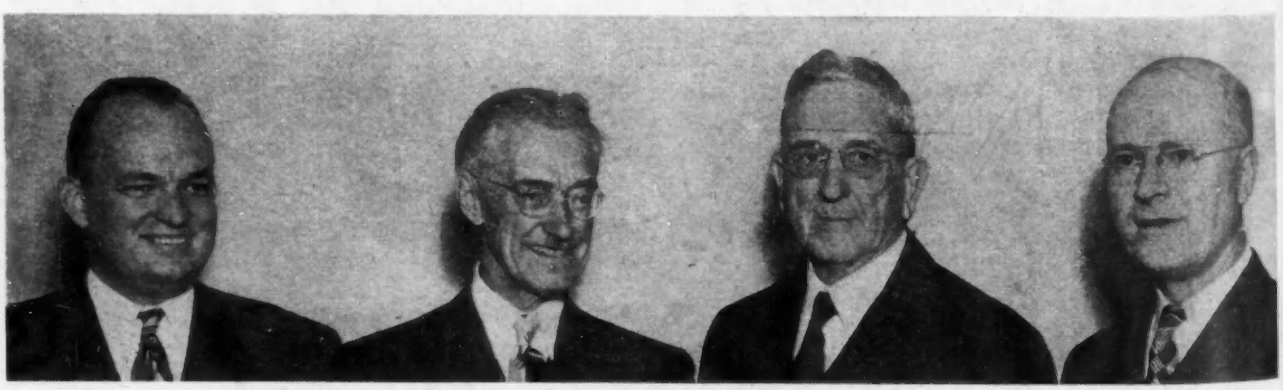
Comparison of costs of all-metal construction for personal aircraft with the older method using mixed metal and wood structural materials with fabric covering produced findings generally favoring the all-metal construction as the more economical from many standpoints. It was concluded that plant requirements for composite construction are more exacting because of the need for fabric covering and painting operations, and greater diversion of materials to be stocked.

Analysis of materials cost for a composite type fuselage showed them considerably higher than materials costs for an equivalent all-metal fuselage, $90.74 to $53.26, while a study of manhours required for the same fuselage construction showed an advantage of 11.20 hr to 20.51 in favor of the all-metal structure. Such a comparison, taking into account only manufacturing costs, and not considering ease of repair and field maintenance, ignores some of the advantages of the composite structure, which still keep it in the picture, it was contended by advocates of the older type construction.

Geared Engines

Advantages of slower turning propellers, fitted to engines with reduction gears, were cited with strong indication of agreement among the engineers that geared lightplane engines are moving rapidly into the picture.

Comparison of a 4-cyl geared engine with a larger 6-cyl direct drive engine showed that the geared engine delivered 160 hp at 1925 propeller rpm (3000 rpm at crankshaft) and 175 hp at 2180 propeller rpm (3400 rpm at crankshaft) for takeoff, while the larger direct drive engine which delivered 190 hp at 2550 rpm would only deliver



Wichita Section Chairman Tom Salter, left, with William B. Stout, dinner speaker, Toastmaster S. A. Long, and President C. E. Frudden photographed at the SAE National Personal Aircraft Meeting, May 1 and 2 at Wichita

Much credit for the success of the National Personal Aircraft Meeting at Wichita goes to Section Secretary D. E. Burleigh, left, who is shown with Treasurer M. J. Gordon, Vice-Chairman A. S. Swenson, and Harold W. Zipp, all of whom were members of Tom Salter's Program Committee

about 135 hp at 1925 rpm and 160 hp at 2180 rpm. Despite the weight of the reduction gear, the smaller geared engine weighed 17 lb less than the direct drive engine.

It was pointed out that the reduction of propeller tip speed would be a step toward solution of the propeller noise problem by merely using a larger propeller diameter turning slower without the help of a new multiblade propeller design.

Discussion brought out a report that from an airplane performance standpoint it is more advantageous to gear engines of as low as 100 hp than to gear larger ones. For airplanes with a design speed variation of 60 to 160 mph it was reported the best propeller efficiency is attained at 800 to 1000 rpm and there is a gain of 8 per cent in efficiency by turning a propeller at 1000 rpm over the efficiency possible by turning it as fast as 2600 rpm.

Development of an experimental exhaust system to make possible engine muffling without power losses due to back pressure entailed an arrangement giving 360 degrees spacing of the exhaust charges carried by any single pipe or manifold. After experiments with pipe sizes, a manifold arrangement with muffler was developed with smaller exhaust pipes than had been previously used, which produced as much or more power than a short exhaust stack arrangement without muffler.

Close coordination between airplane and engine manufacturers, in muffler applications, to eliminate or at least minimize power losses, was urged.

Cooperation is Urged

Use of superchargers is seen as efficient on engines of 300 hp and above, but not on the smaller engines commonly used on light planes because of the additional weight and cost and the relatively small gain in performance which can be attained otherwise by using a controllable pitch propeller.

Forecast as current and near future powerplant developments were nonicing fuel metering equipment, exhaust muffling, modified controllable propellers, and other means of reducing airplane noise. Multiblade controllable propellers for noise reduction are farther in the future, but may come unless simpler means is found for reducing propeller noise. Reduction of piston and gear noise in engines probably will precede corresponding decrease in propeller noise.

Advantages cited for fuel injection systems for small airplane engines included: elimination of manifold icing, better engine idling characteristics, faster acceleration, lower maximum cylinder head temperatures, increased fuel economy, increased

Chairman at the five technical sessions of the SAE National Personal Aircraft Meeting were **W. E. Burnham, W. H. Roesing, T. A. Wells, Peter Altman,** and **W. H. Zipp.** The 12 papers presented and their authors were "Evolution of an Automatic Variable-Pitch Propeller," by **J. D. Waugh,** Koppers Co., Inc.; "Better Propellers for Light Pocketbooks," by **J. F. Haines,** Aeroproducts Division, General Motors Corp.; "Engines for Light Aircraft," by **D. S. King,** Lycoming Division, Aviation Corp.; "Problems of Helicopter Powerplants," by **Robert Insley,** Continental Motors Corp.; "Fuel Injection versus Carburetion for Personal Airplane Engines," by **G. M. Lange,** Ex-Cell-O Corp.; "The Relationship of Aircraft Detail Design to Tooling and Manufacturing Cost," by **W. A. Davidson, R. E. Saunders, P. E. Pelley,** and **J. W. Rix,** Beech Aircraft Corp.

"Comparison of Use of Mixed Structural Materials and Fabric Covering to All-Metal Construction for Personal Aircraft from a Manufacturing Viewpoint," by **W. C. Jamouneau,** Piper Aircraft Corp.; "Development of the Beech V Tail," by **M. J. Gordon,** Beech Aircraft Corp; "Design for Power Soaring," by **E. H. Rowley,** Boeing Airplane Co.; "Experiments With Converted Automotive Engines for Light Aircraft Powerplants," by **H. C. Funk,** Funk Aircraft Co.; "Adaptation of Automotive Electrical Equipment for Personal Aircraft," by **J. E. Hiday,** Delco-Remy Division, General Motors Corp., and "Control and Stability Characteristics of a Simplified Helicopter" by **Charles Seibel,** Boeing Airplane Co. All of these papers will appear as feature length articles or in briefer form in forthcoming issues of the SAE Journal. Those approved by Readers Committees will appear in full in the SAE Quarterly Transactions.

horsepower, longer engine life between overhauls, simplification of engine cooling, flatter engine designs.

Discussions of converting automotive engines and other automotive equipment for use on personal planes resulted in conclusions that the automotive engine and airplane engine were two different breeds of powerplant and that it was extremely difficult and expensive to convert the auto powerplant for flight. Experiments in converting a 40 hp 4-cyl liquid-cooled Ford engine weighing 350 lb, for aircraft use through adaptation of aluminum cylinder head and other lightweight aluminum parts, were described.

By altering the cylinder block a valve assembly from a Plymouth engine was installed. Eventually the converted engine was installed at inverted position, at weight of 305 lb, with radiator and coolant, and delivered 63 hp at 2135 rpm.

Parts Cost Less

Crankshaft failures and piston failures were eventually overcome and the manufacturer, in prewar days, built and sold approximately 100 planes with converted Ford engines. A principal problem was to convince the users that they could not replace wornout parts with low-cost automotive replacements.

Another postwar study on automotive engines involved the use of a postwar Crosley 25 hp automobile engine in a tiny one-place aircraft. By using a wedge belt reduction drive a reduction ratio of 2.05 has been attained on the engine rpm of 4500. The plane has not yet been flown, but a 150 hr test run with CAA witnesses has been completed on the engine. The engine was originally adapted from a generator engine, for use in the midget car.

Reports on this conversion to aircraft use were cautiously optimistic, indicating good results thus far during the early stages of development. The small plane is expected to cruise at approximately 100 mph and to have a considerable range due to the fuel economy of its small engine. Manually retractable landing gear is another feature of the plane.

Use of automotive electric equipment, adapted for aircraft use, with emphasis on generator equipment, has been generally satisfactory, the Wichita engineering meeting was informed, although problems of lightening the equipment, by substituting aluminum for steel where possible, have had to be met, without seriously increasing costs. Increased generator capacity will be necessary on the light airplanes, as additional equipment is used, and more night operation is done. More dependable electric equipment for airplanes at a lower price is promised by research now in progress.

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STRESSCOAT ANALYSIS

continued from page 28

peripheral speed is made equal to the desired forward speed of the airplane. The test wheel is landed and held against the flywheel at the desired radial load by an air cylinder.

In one test, the wheel was rolled without landing shock at the rated load of 11,000 lb for 10 sec, then again at 50% and 100% overloads for 10 sec each. After each load application the wheel strain patterns were contoured with a scriber. The wheel was then rolled at 16,500 lb (50% overload) for 3 min, at which point the tire blew out, the wheel bottoming on the flywheel.

The goal of obtaining compression patterns was not attained but the results demonstrate several phenomena of Stresscoat and deserve consideration. Fig. 3 is an overall view of the inboard side of the wheel showing the four coated sections, the tire failure at the bottom of the picture, and the point of impact on the flywheel evidenced by flaking of the coating. The wheel was rolling counterclockwise as viewed.

Fig. 4 is a close-up of the spoke with the most sensitive coating, the bottom spoke in Fig. 3. Here can be seen the growth in contoured areas of tension patterns as the load was increased.

The large pattern over the whole spoke was suspected of being a compression pattern. But a further test with strain gages showed that the rolling load compression peak at the center of the spoke was only 0.0010 in. per in. This could not be expected to produce compression cracks in 3 min even if the strain were not reversed. Its tension peak of 0.00025 in. per in. at the rolling load would need to be only doubled to produce a pattern of cracking intensity; furthermore the tension peak occurs at 130 deg from either side of the point of load application.

It can be seen in Fig. 3 that the impact load was almost exactly 130 deg from the spoke in question. Therefore, the pattern is a tension pattern, caused either by the impact load or by increased tension sensitivity due to compressive creep under extended cycling.

Fig. 5 shows one spoke adjacent to the impact spoke. Several patterns cross; but note particularly the cracks running essentially lengthwise of the spoke. According to Poisson's ratio, a simple compressive strain is accompanied by a perpendicular tensile strain of about 0.35 its magnitude in magnesium.

For example, if a simple compressive strain of 0.0020 in. per in. were imposed lengthwise on a spoke with a coating sensitivity of 0.0006 in. per in., then coating cracks running lengthwise of the spoke could be expected corresponding to the tensile strain of 0.0007 in. per in. (0.0020 x 0.35) across the spoke.

Airport Design Blends Economics With Ground and Air Engineering

EXCERPTS FROM A PAPER* BY **Charles Froesch** CHIEF ENGINEER, EASTERN AIR LINES, INC.

THE airport engineer must create efficient and lasting accommodations by a clear understanding of airport functions. He must properly balance the components of an airport to assure the safeguarding of public funds invested in the project. He must design for flexibility of expansion in anticipation of future growth. He must plan for maximum utility for the greatest number of people.

The following must be satisfied for the sound development of any airport:

(1) Location:

Necessity dictates that airports be located as close to traffic generating centers as practicable. Rules for the selection of a suitable location cannot be expressed mathematically. The final decision is often a compromise dictated by terrain topography and airport size.

Large cities have high traffic potential. They need large airports to accommodate large capacity aircraft, and large tracts of land can seldom be found close to the center of the city. On the other hand, accessibility to the airport is of major importance, irrespective of its location. Whether it be close in or farther away, it should therefore be linked with the traffic hubs, industrial and residential, by expressways.

Smaller towns may find it more expedient to

*Paper "The Planning and Engineering of Airports," was presented at SAE National Air Transport Engineering Meeting, Chicago, Dec. 2, 1946.

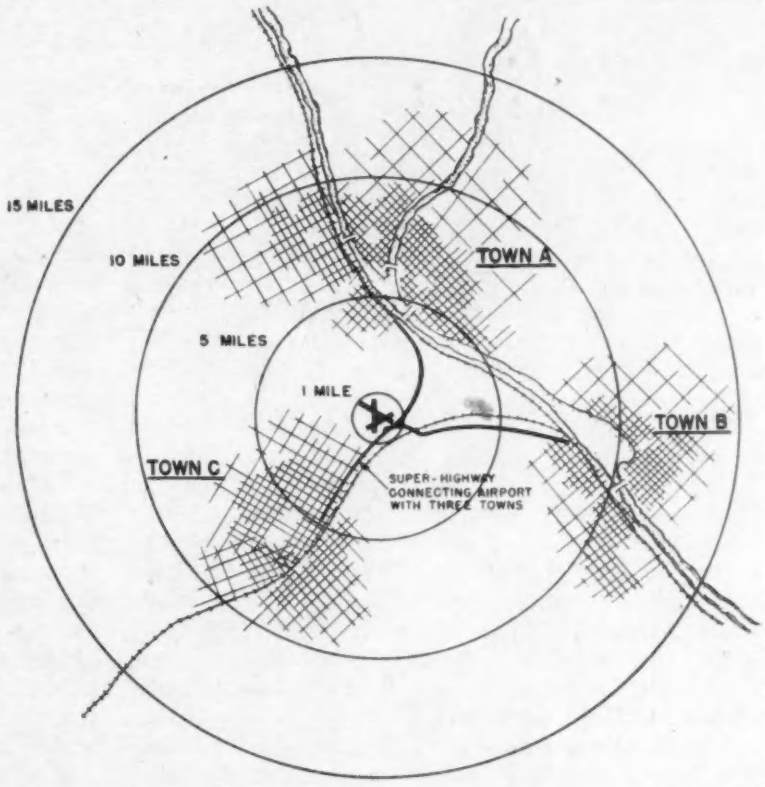
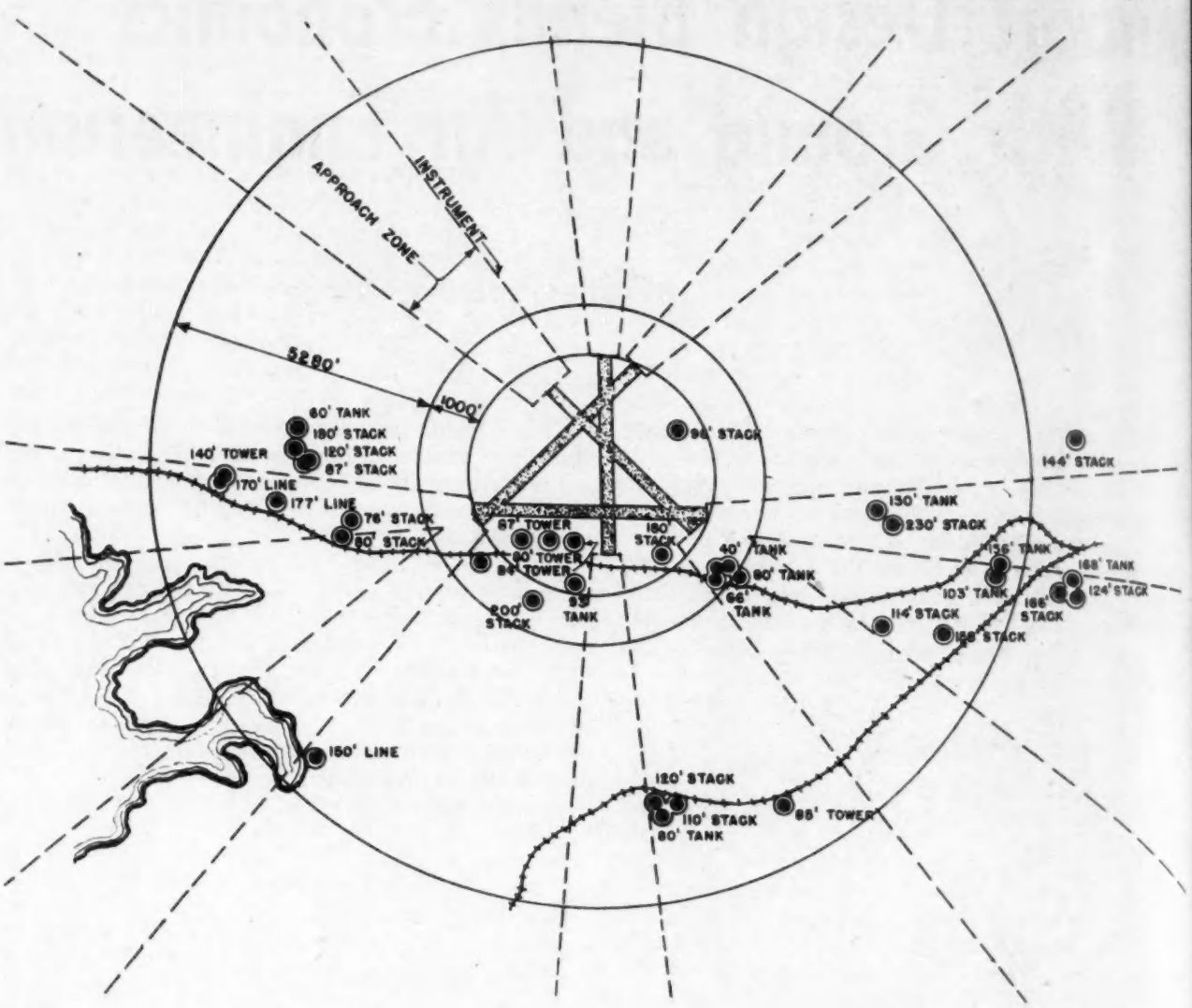


Fig. 1 – Building one airport to serve several smaller towns provides each community with greater facilities at less cost than if each were to construct its own airport. In the case of large city airports, accessibility to traffic hubs is paramount in selecting the site. Positioning of the airport with reference to existing airways and adjacent airfields should permit a satisfactory airway pattern during low visibility and ceiling conditions

Fig. 2 – Early step in selecting the airport site is the preparation of such an obstruction map. It indicates obstacles in the glide path



pool their aviation interest and develop a joint venture for the region (Fig. 1). This will promote a greater degree of airline service and permit development of more spacious facilities at lower cost than if each town built its own airport.

(2) Adequate Size:

There is a definite relationship between aircraft performance and airfield size. A serious mistake in the past has been to build landing facilities in locations where future expansion was economically impossible because of surrounding terrain topography or costly real estate developments. This shortsightedness resulted in premature obsolescence of such facilities when air traffic grew and larger equipment was needed. While it is unwise to build on too large an area, it is more so to build on too small an acreage.

A good rule to follow is to acquire sufficient land or option it to meet the requirements of the next largest airport classification. This precaution is desirable because the elimination of the stalling speed regulation from the Civil Air Regulations permits aircraft designs having higher wing loadings. This, in turn, renders the runway length required for landing often more critical than for take-off and limits the maximum payload of such aircraft when used on relatively small fields.

(3) Obstructions and Zoning:

Before final decision is made on any site selection, an obstruction map should be made of the surrounding area, varying from say a two-mile radius for airparks up to five or six-mile radius for a major airport. This map, like the one in Fig. 2, should show the elevation and location of all natural and man-made obstacles to determine the permissible gliding angles if located on the approach zones of the runway.

The CAA prescribes that a minimum glide ratio

of 20 to 1 is satisfactory for the smaller airports and a 40 to 1 for airports designed for instrument operation. It is the consensus of the air transport operators that a 50 to 1 glide ratio is more desirable for the latter. Should any obstruction prevent these ratios, either they must be removed, the airport system reorientated, or the site abandoned.

(4) Meteorological Conditions:

A study of weather conditions for at least two to three years preceding the site investigation should be made to determine the prevalence or recurrence of smoke, dust, or fog; also the directions and velocity of the wind, rainfall, and degree of precipitation. Wind direction and velocity will affect runway direction and length, and rainfall will dictate, to a large degree, the design of the drainage system.

(5) Cost:

One of the factors which affects the cost of building an airport is the availability of utilities such as electricity, water, gas, telephone and telegraph, and sewer lines.

Airfield Design

The airfield – that portion of an airport used for the landing, take-off and taxiing of aircraft – represents a large percentage of the total airport cost and must be designed to handle the dispatching capacity of the terminal building as dictated by actual and projected air traffic under good weather conditions. Although this rate of air traffic is much higher than experienced under instrument operation, it is generally agreed that any airfield should be able to take care of the airway capacity over it in good weather.

It is considered more economical to design for good weather operation and to increase capacity by adding runways later for instrument operation if improvements in aerial navigation and control fail to materialize later on.

Again, there are few rules to guide the airport engineer in determining the best layout for any particular airfield because the art is yet too new and aircraft development is too dynamic; but there are, in each case, minimum runway requirements which must be met for any given aircraft. Once concrete is poured or asphalt rolled, alterations are expensive.

The characteristics of a good airfield design can be listed as follows:

a. Adequate runway length and adequate separation when a parallel system is used;

b. Allowance for landing, take-off, and taxiing as independent operations without interference;

c. Shortest possible taxi distance from the aircraft loading apron to its take-off point;

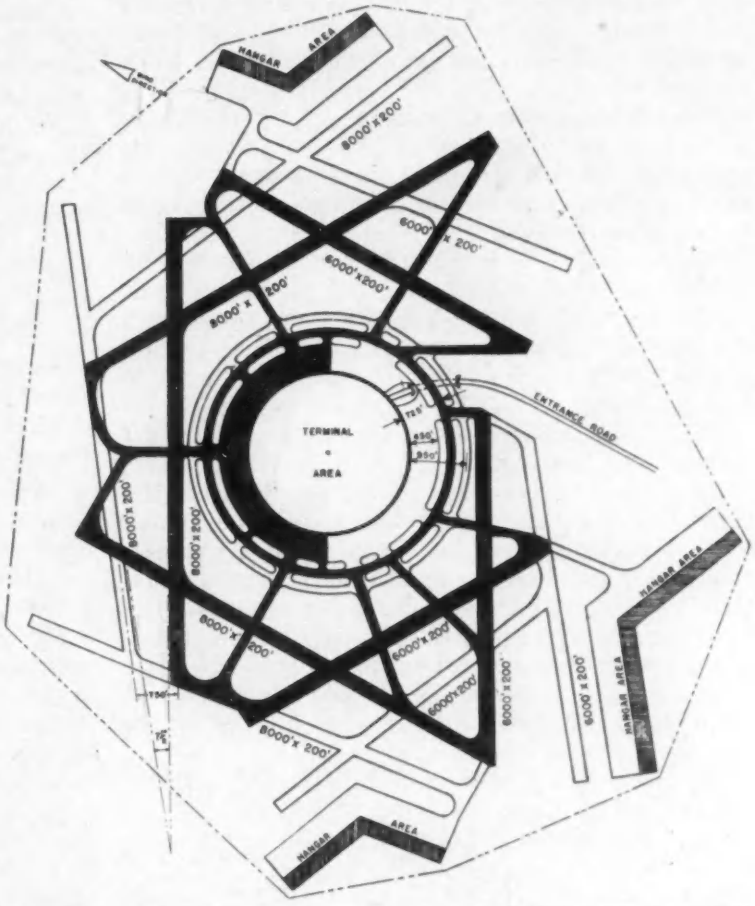


Fig. 3 – Constructing outer and inner runways at an angle to each other eliminates complicated air traffic patterns occasioned by parallel landing and take-off runways. The black areas show the first stage of development, providing for 120 operations per hr and a loading apron capacity of 30 plane positions at a 150-ft average spacing. After expansion, with the white areas added, the airport will accommodate 240 operations per hr and 60 plane positions at the same spacing on the loading apron

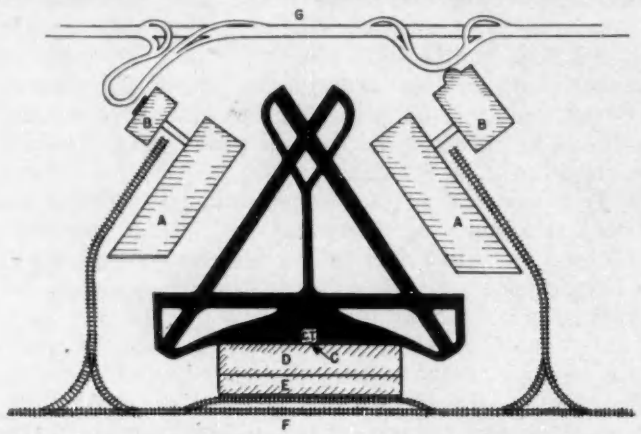


Fig. 4 – Triangular runway patterns go well with an industrial airport such as this one, which includes (A) the manufacturing plant, (B) the plant office, (C) the control tower, (D) hangars or salesrooms, (E) warehouses, (F) railroad, and (G) highways

d. Safe approach zones with satisfactory glide path ratios;

e. Land acreage sufficient for future runway pattern expansion;

f. Lowest cost of construction.

Types of Runway Patterns

Selection of a proper runway pattern is the first step in airfield design. It is affected by the wind rose, the shape of the plot of land, the topography of the terrain, and the volume of air traffic to be handled.

The simplest form of landing and take-off facility is the single flight strip. It is the logical pattern where the winds blow from the same direction or its reciprocal and when traffic requirements do not need more than 30 to 40 movements per hour.

Where land is available, it can be made long enough so that one-half of its length can be used for landing and the other half for take-off – with the passenger loading station and administration building in the middle. This reduces taxi distance to a minimum. It can be paralleled to increase its capacity, with proper separation for simultaneous take-off and landing.

As more complete wind coverage is desired, the runway configuration must take an angular shape. In this respect, there has been much discussion about triangular versus quadrilateral runway patterns. The choice between a 45 deg and a 60 deg basic runway system rests primarily on the degree of crosswind which present and future aircraft can safely negotiate during landing and takeoff.

Airplanes equipped with tricycle landing gears are more stable than those equipped with tail wheel. The trend toward higher landing speeds, due to higher wing loadings, will enable future transport airplanes to take off with greater crosswinds than now believed safe.

When capacity of 240 airplane operations per hr is required and while this is still questionable under instrument operation, the 60 deg dual runway pattern can be paralleled. The first stage of development is similar to the open parallel pattern and the capacity is increased by paralleling each one. To obtain the maximum capacity of this type of pattern, all landings should be made on one side of the terminal area and all take-offs on the opposite side.

While the operation of a pattern of this type appears to be quite satisfactory on the ground, it involves an air traffic pattern which is more difficult of accomplishment because of the parallel landing and take-off runways. This can be overcome to some extent by positioning the outer runways at an angle from the inner runways, as shown by Fig. 3.

An example of the flexibility and efficiency of triangular runway patterns is given in Fig. 4, which shows how they can be applied to an industrial airport.

Location of Site

The location of the terminal area of an airport will depend to some degree on its size, which in turn is predicated on the traffic survey of the region.

Any site on the airport selected for the terminal area should have ample area for the first stage of building development and any future expansion, as may be dictated by the airport master plan. It should also provide for an efficient system of roadways within the area and airport as a whole, as well as ample car parking area.

It should be developed in balance with that of the airfield so that when it is expanded to the last stage, every square foot of land will be efficiently utilized.

For the airline airport emphasis should be placed on the expedition of vehicular traffic to and from the airline gates during peak traffic hours.

Numerous other detail engineering problems pertaining to the design of an airport have many ramifications dealing primarily with civil and industrial engineering. I have endeavored to present the engineering aspects dictated by the aeronautical requirements of airports.

The airport engineer must conceive *broadly;* he must design *flexibly;* he must engineer *functionally* that the final result of his effort may be a facility of lasting economic value and utility.

He cannot complacently dream of applying his pet ideas without first making certain that they are realistic of execution. His task is to appraise and to translate, as accurately as he can, the results of long range traffic surveys into air travel accommodations on the ground. He must strive constantly to make it easier, faster, and cheaper too, for the air traveler to fly, as well as to provide an attractive civic center for the people of the region.

Precision Casting Opens NEW VISTAS for Design Engineers

BASED ON A PAPER* BY

G. VENNERHOLM and E. ENSIGN FORD MOTOR CO.

(This paper will be published in full in SAE Quarterly Transactions)

INCREASED freedom in design and more latitude in selecting materials is offered to design engineers through recent improvements in precision casting techniques. Today's limitations on design of powerplants, transmissions and other automotive components will be removed by better understanding of materials and processes made possible by:

- Die casting;
- Permanent mold casting;
- Investment molding – possibly more properly known as slip molding;
- Plaster molding, and
- Combinations of two or more of these techniques.

Higher yield due to fewer and smaller gates and risers is obtained by all precision methods as compared with conventional casting techniques. Eliminating machining adds a most attractive advantage to these processes. The amount of machining which may be eliminated depends upon the willingness to refine the tools for the particular casting in question.

Costly bars, strips, sheets and other forms of raw material are not needed, and we see in precision casting the shortest distance from raw material to finished product.

Although in some precision casting methods the initial equipment cost is high, this is inversely proportional to the number of parts cast, because life of the tools is great.

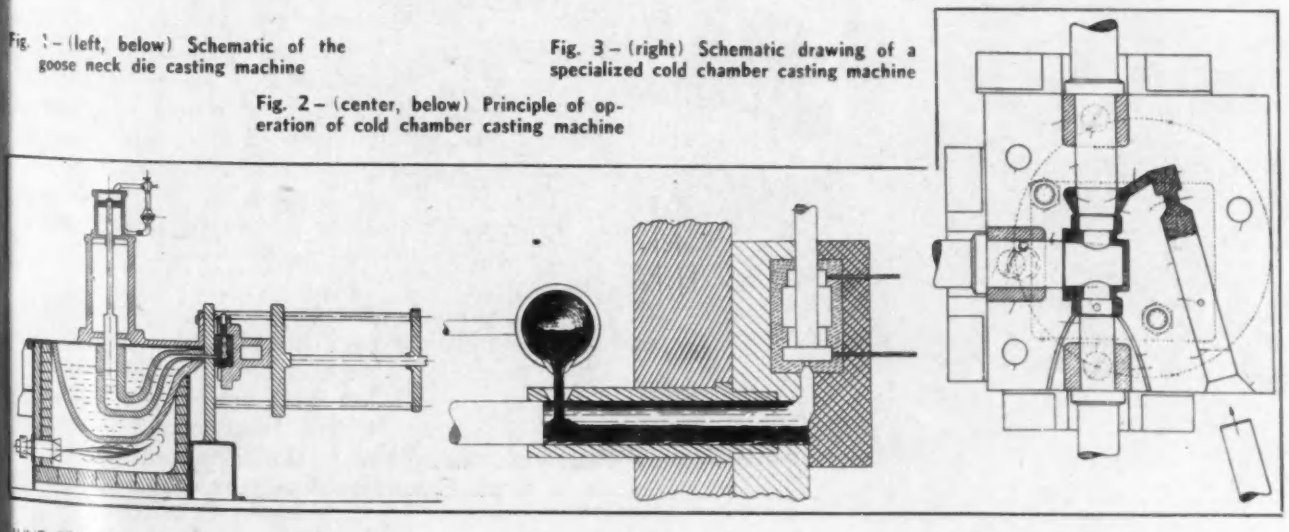
Formerly only a limited number of materials were used – such as lead, zinc, brass, aluminum, and for small objects, the precious metal. Shapes cast were in general relatively simple and the weights were in terms of ounces. Now we are able to consider the higher melting metals and alloys as well, making our selection on the basis of the function of the part rather than suitability to a

* Paper "The Manufacture of Precision Castings" presented at the SAE 1947 Annual Meeting, Jan. 6, 1947, Detroit.

Fig. 1 – (left, below) Schematic of the goose neck die casting machine

Fig. 3 – (right) Schematic drawing of a specialized cold chamber casting machine

Fig. 2 – (center, below) Principle of operation of cold chamber casting machine



particular casting method. Weights of parts cast have increased many fold.

Die Casting is perhaps the oldest form of precision casting in the automotive field. This method was originally used only for low melting alloys, but continued developments in both machines and casting alloys made the successful manufacture of aluminum castings possible as early as 1916, and at a later date, magnesium and copper base alloys were die cast.

Types of die casting machines are (a) goose neck, (b) plunger, and (c) cold chamber machine. Although in principle the same, they differ in the method used to inject the metal into the die. Common to all is a fast working machine in which water cooled dies are mounted so that one die section is stationary and the other is attached to a moving carriage. A suitable device is incorporated to strip the finished casting from the die. Figs. 1, 2, and 3 show principles of goose neck and cold chamber machines.

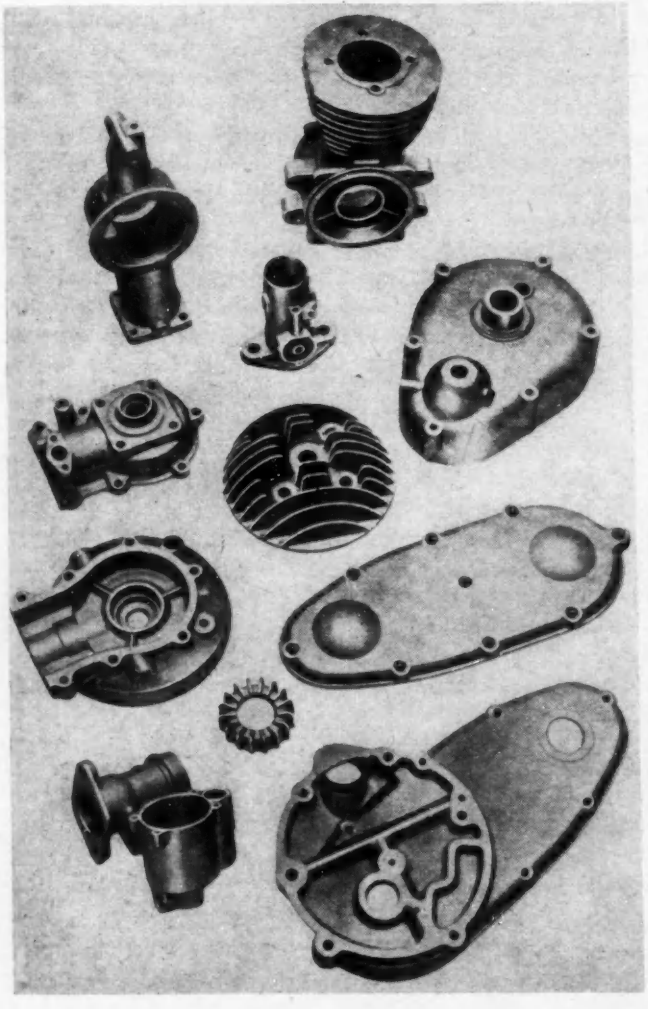
Goose neck machines, used mainly for aluminum, are limited in the pressure applied upon the metal in the die cavity to about 600 psi – not sufficient to exert a squeeze action on the metal while it is in the plastic state. The production rate does not usually exceed 110 shots per hr.

Plunger machines use a cylinder or pressure chamber fitted with a piston or ram inserted in the molten metal. Metal is forced into the die by exerting pressure of from 1500 to 3000 psi on the piston by pneumatic, hydraulic or mechanical means. It is used for casting tin and lead base babbitts and zinc base alloys, at a rate of from 100 to 400 shots per hr.

Cold chamber machines are the most modern and by far the most effective machines used for aluminum, magnesium and copper base alloys. This cold chamber machine consists of a pressure chamber fitted with a power ram. Metal is ladled from the melting pot into the chamber and forced into the die by applying hydraulic power to the ram (Fig 3).

Pressures as high as 100,000 psi are used, making it possible to exert a squeeze action during solidification and while the metal is plastic, thereby simulating the extrusion press principle. The result is a casting of greater density and dimensional stability. The cold chamber machine is limited to 150 shots per hr, but because more multiple cavity dies can be used it often exceeds the rate of goose neck or plunger machines. Typical castings are shown in Fig. 4.

Fig. 4 – Products of plunger and cold chamber die casting machine for automotive components



Permanent Mold Process, although similar to die casting, differs in that the metal is introduced into the die by gravity. Perhaps the English term "gravity die casting" is more appropriate, because mold life is limited.

Simplest form of this process consists of two die halves which are clamped together and into which the metal is ladled by hand. When greater accuracy is required and larger or more complex castings are to be made, the dies are usually mounted in a mechanically or hydraulically operated machine, one half being stationary and the other half sliding. When design permits, the two die halves are frequently hinged together thereby simplifying the mechanism. Typical non-ferrous castings are shown in Fig. 5.

Production rate of these machines is generally about 25 to a maximum of 75 fills per hr. Die material used generally is a heat-resistant alloy cast iron which permits casting to nearly finished shape, thereby effecting a considerable saving in cost as compared with machined and heat treated steel dies.

By far the largest tonnage made by the permanent mold process are aluminum castings, with copper-base alloys as a close second. Some zinc-alloy castings are also made but these are inferior to die castings and are frequently replaced by aluminum castings when the permanent mold process is used. Considerable quantities of gray iron

are manufactured by the permanent mold process.

Semi-Permanent Mold Process is a modification which permits complex internal shapes by using inserted refractory cores of sand or plaster.

Die Casting Versus Permanent Mold Casting

These various methods offer the solution to many design as well as production problems despite their limitations. Applicability of these processes to the manufacture of a given part is determined by: (a) type of metal to be cast, (b) required tolerances and surface finish, (c) size, shape and minimum wall thicknesses of castings, (d) soundness and physical properties, (e) total number of castings to be made and rate of production.

a. Both methods are used to cast aluminum, magnesium, copper base alloys, and tin and lead base babbitts. Zinc base alloys are usually die cast and generally replaced by aluminum when made by the permanent mold process. Ferrous castings, and to a limited extent steel, are made by this process.

b. For maximum accuracy and best surface finish the die casting process excels the permanent mold process.

c. The permanent mold process now permits much larger castings to be made than is possible with the die casting process, with 50 lb in aluminum not unusual for the former and 20 to 25 lb being the maximum for the latter. Complicated designs or thin walls are encountered, usually call for pressure die casting.

d. The high injection pressure used in the die casting process usually traps some air in the casting resulting in porosity. Although the permanent mold casting is not always free from porosity, it is sometimes found that heat-treatable aluminum alloys cast in permanent molds produce higher properties after heat treatment.

When casting gray iron by the permanent mold process, high internal pressure resulting from graphite precipitation aids materially to produce sound and dense castings.

e. The total castings to be made and the rate of production will affect selection of the method provided that both are applicable. Short runs, on the other hand, can frequently be made more economically by the slower permanent mold process because of much lower installation and die cost.

Investment Molding is the oldest form of precision casting. It is popularly called the "lost wax method." This method was used in one form or another in China as early as 1766 to 1122 B.C., and also in early Greece.

A true replica of the part is made in wax. This is placed in a container and covered with a suitable investment material. Heat is then applied to melt out the max, thereby leaving a cavity of the desired shape into which the metal is cast.

It was not until World War II that American industry in general realized that this method makes possible the mass production of vital heat- and abrasion-resistant alloy parts, inherently difficult to machine, to tolerances so close that little or no machining is required.

Fig. 6 shows parts made in stellite, shows the dimensions of one of these parts, and indicates why ordinary methods of manufacturing were unsatisfactory.

Ford Motor Co. before the war had applied this method to production of high speed tools of complicated shapes, such as milling cutters and similar intricate items requiring extensive machining operations.

First consideration when using the investment method is the wax model and the wax itself. The part can be no more accurate than the model and the model no better than the tools and materials used to form it.

Suitability of a wax depends primarily on its shrinkage stability. A typical composition, satisfactory for a number of applications, is 31.33%

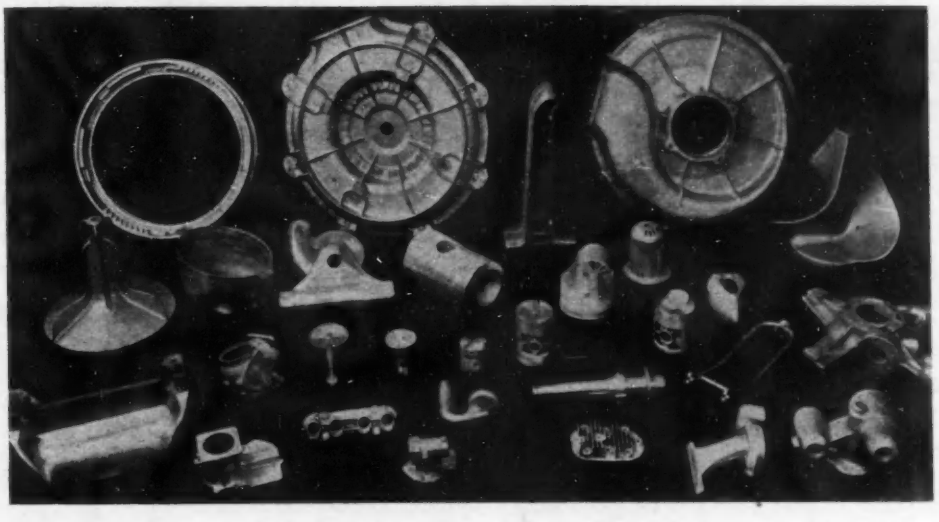


Fig. 5 – Typical permanent mold castings of non-ferrous parts. Aluminum, copper base, zinc, and non-ferrous alloys are cast by this method

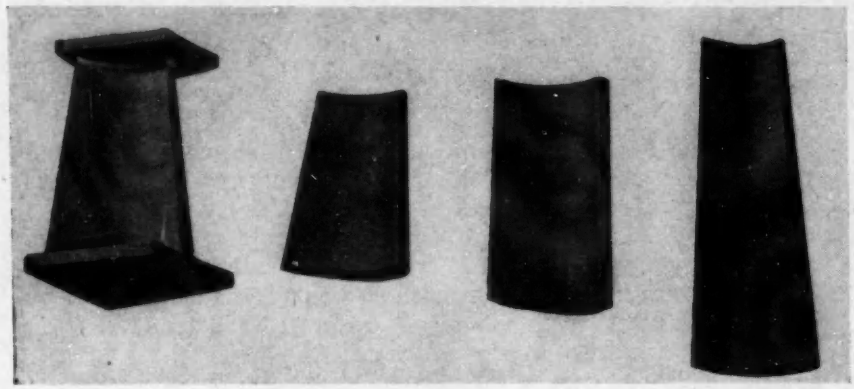
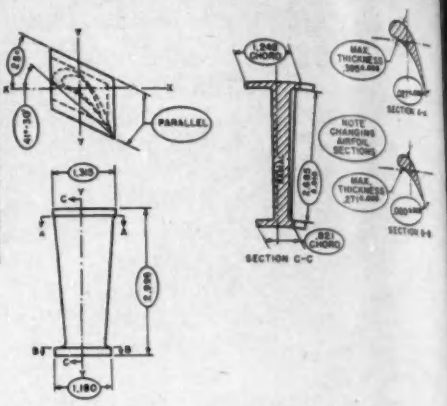


Fig. 6 – Stellite turbine blades cast by investment molding by new techniques which revived an ancient art. Drawing gives dimensions of part



Blue Bulk wax, 31.33% Superlo wax, and 31.33% Cincera wax.

Several wax models can be joined together to form a cluster, the joining wax becoming the necessary runners and sprues. The wax used for this purpose need not be of the same quality as that used for the model.

Dies are generally made from steel for dimensional stability and wear resistance, although recently some dies have been cast from low melting alloys chosen for ease of machining and working. Careful consideration must be given to parting lines and the ability of the die maker to machine the dies to eliminate any flash.

All successful investment compositions for high temperature work have been basically silica, silica base binder, alcohol, and water. This has been successful: 67% silica, 33% liquid made up of eight volumes silica base binder, one volume of water and two volumes of alcohol.

After curing material, the mold is ready for burning. It is placed in a cold furnace and heated at the rate of 300-400 F to 1400-1500 F and held at this temperature for two to three hr to completely burn out all wax and to thoroughly dry the investment.

As the process has been developed at Ford's, the mold is removed from the firing furnace while hot and clamped on top of the specially designed melting furnace. The metal to be cast is melted in indirect electric arc furnaces in the quantity necessary to fill one mold. In operation the furnace is raised to a temperature of about 3000 F while empty. Then the charge is introduced through the arc. After withdrawing the electrodes, the cast is made by inverting this assembly.

Investment molding's greatest advantage is that it permits the manufacture of practically any alloy regardless of melting temperature into almost any shape regardless of internal or external contour, with size the only limitation. Its major disadvantage is the high cost of raw materials used and the time required for curing and burning the investment.

The model material must be cheap, have small and definitely calculable shrinkage, be easily injected and readily joined to itself, and be capable of reuse without extensive reprocessing. The investment material also must be of low cost with small calculable shrinkage or growth, and be capable of being held in a castable form over sufficient periods to permit feeding continuous casting equipment. It should be reusable.

These conditions are near enough to predict use of investment casting for manufacturing engine parts, gears, and chassis parts will soon be at hand.

Plaster Molding has been used for years in making ornaments from bronzes and low-melting lead-base and tin-base alloys. With development of suitable aluminum alloys in more recent years, and need for decreasing weight, this method may well be considered for precision casting aluminum and bronze.

It consists of casting a mold in plaster around a metal pattern and then, after suitably curing the plaster mold, casting the metal. Its quality and exactness depends on the degree to which the models or patterns are refined.

The pattern is usually made of brass. It is durable and less subject to the corrosive effects of the plaster slip. The finish on the pattern must be of very high quality.

Newly developed plaster mixes make this a desirable method. The dimensional stability of low density plaster during curing and calcining produces a more faithful replica of the pattern surface.

A typical analysis of a plaster suitable for aluminum is 30 parts by weight of gypsum, 10 parts of talc, 2 parts of an accelerator and 60 parts of water.

Merely controlling the plaster mix ingredients is not sufficient to secure a good mold. The process must be carefully timed and manipulated from the time the dry ingredients are mixed until the mold is taken from the calcining furnace.

concluded on page 47

Urge INTEGRATED Landing Aids

BASED ON A PAPER* BY

RAY D. KELLY Superintendent of Engineering Development **and**

ROBERT L. CHAMPION Director, Landing Aids Experiment Station

United Air Lines, Inc

PROPER combinations of landing aids, if effectively integrated, will insure independence of weather to an extent now undreamed of for scheduled air transport.

No one landing aid by itself will achieve the necessary safety and reliability which are essential to the ultimate transportation system. Each fulfills certain essential requirements, and each must be used in proper coordination with others if the airlines expect to operate independently of weather conditions.

Basic components of the integrated landing aids at the Landing Aids Experiment Station, Arcata, Calif., consisted of:

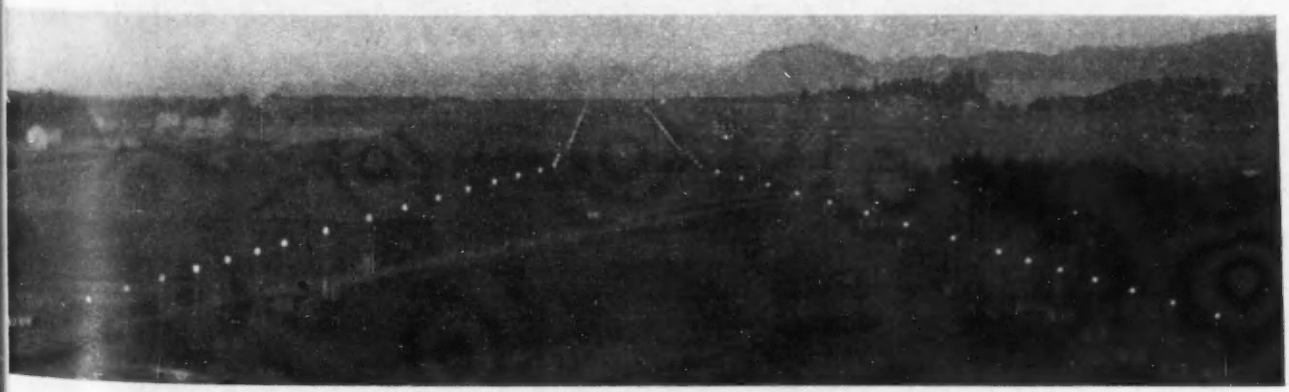
- Electronic low approach aids to assure the plane being brought down precisely and safely down the approach zone to the runway at an altitude, heading, and speed suitable for final approach and landing;
- Suitable markings of final approach and runway areas so the pilot can be certain of his location, and have adequate visual reference points for completing a contact landing, and
- Fog dispersal system for extremely poor visual conditions to insure visibility of the final approach and runway areas for the pilot as he terminates his approach and sets the plane on the ground.

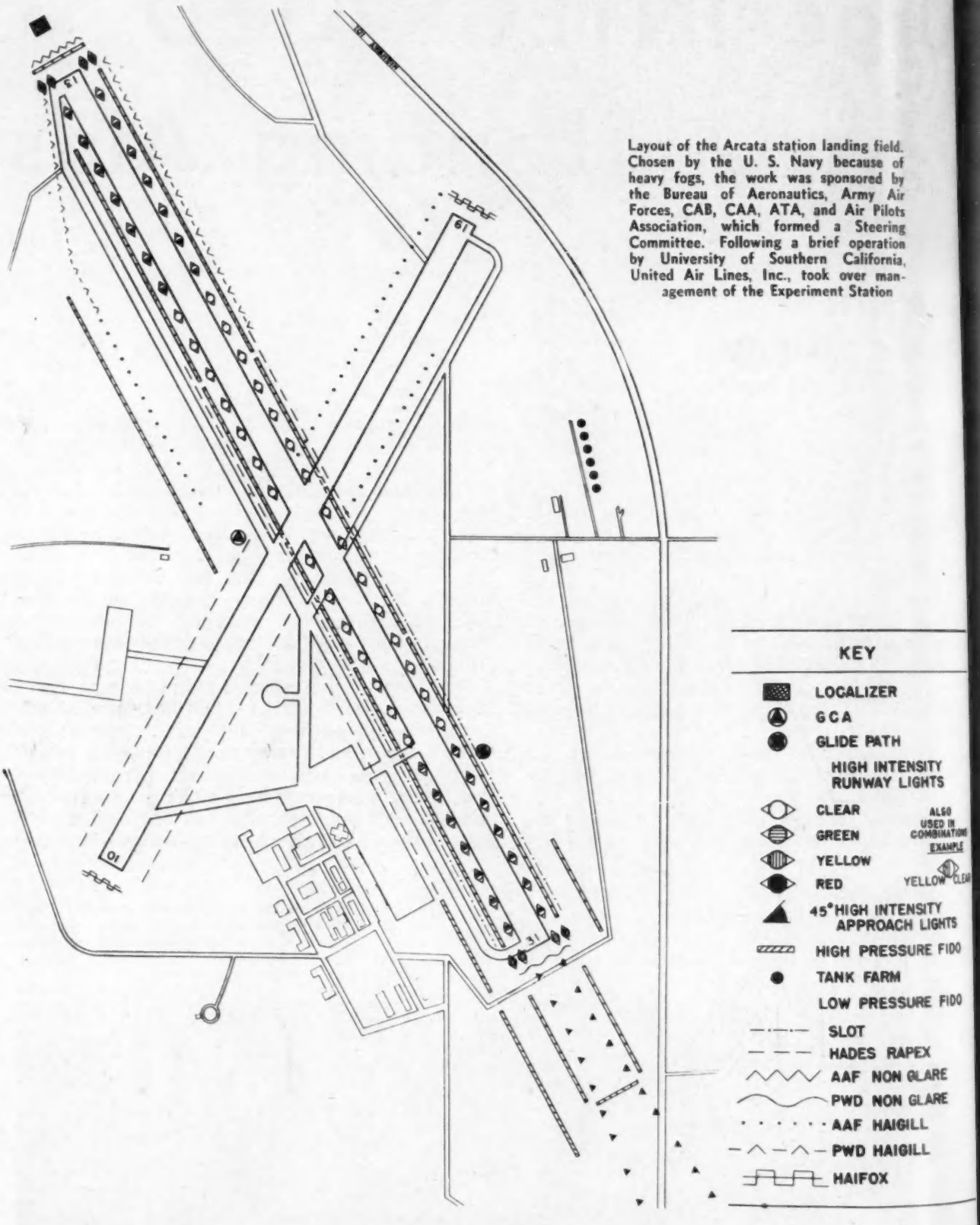
The experimental work at Arcata was based upon the assumption that, for schedule reliability and safety approaching 100%, civil airports:

Need competent airway traffic control into and out of the area, require coordinated traffic schedules through cooperation of all lines, must maintain – at least to start with – an unassigned 20% slack in the maximum schedule possible. The latter

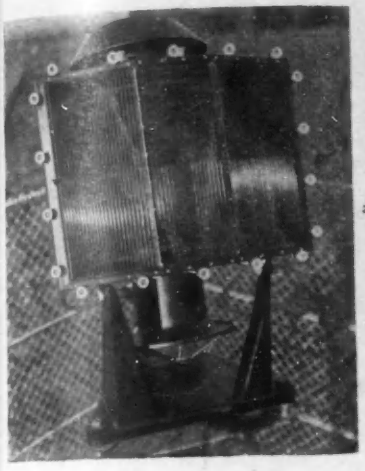
*Paper "Integrated Landing Aids" was presented at the SAE National Aeronautic Meeting (Spring), April 9 to 11.

Aerial view of the Arcata Landing Aids Experiment Station looking down the instrument runway. Backbone of this system is an electronic low approach aid. Either ILS (SCS-51) or GCA radar equipment can be used, but the authors favor ILS





Layout of the Arcata station landing field. Chosen by the U. S. Navy because of heavy fogs, the work was sponsored by the Bureau of Aeronautics, Army Air Forces, CAB, CAA, ATA, and Air Pilots Association, which formed a Steering Committee. Following a brief operation by University of Southern California, United Air Lines, Inc., took over management of the Experiment Station



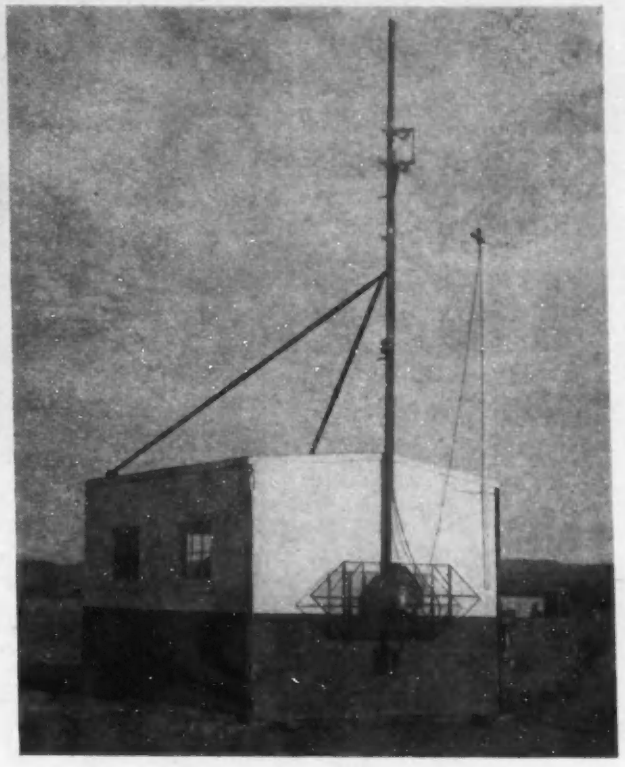
One of the five landing aids at Arcata Station was high intensity approach lights, left, and high intensity runway lights, right. The American Gas Accumulator Co. design for the former is at the left. The runway light shown is the Bartow D-1 runway marker

would normally, at two-minute intervals, permit landing 24 planes per hr.

The same routine should apply to take-off clearances.

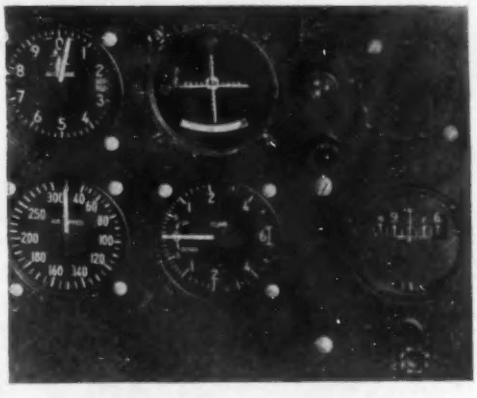
Adequate equipment is required to achieve this routine so that straight in approaches for landing will always be possible. Identical flight procedures and ground control methods must be used for every landing, except for emergencies, *regardless of the condition of the weather.*

Routines and the maximum number of schedules handled at any airport during any hour should be predicated on the worst weather conditions. Any laxity in good weather only increases the stress on the human element under less favorable circumstances. And any program must provide an adequate margin of safety.

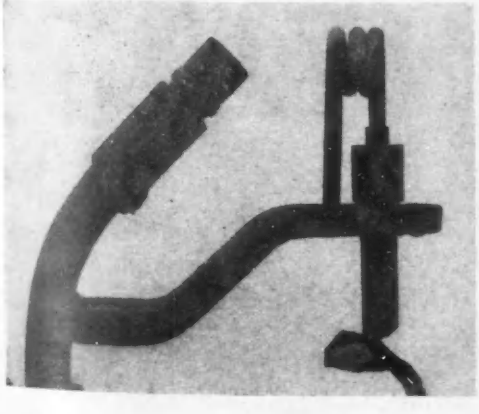


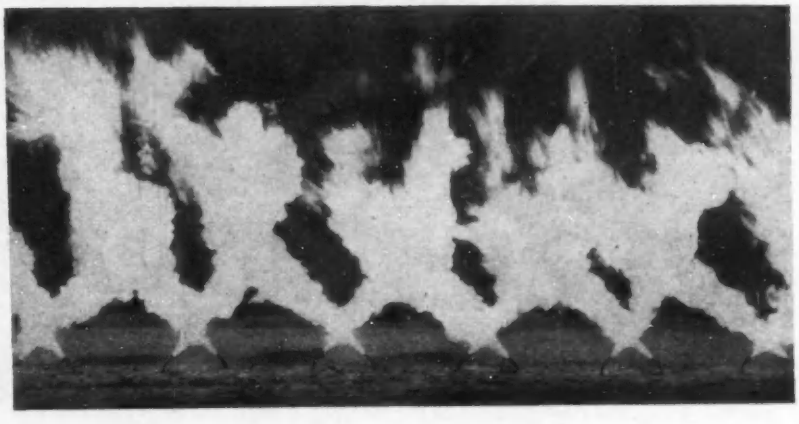
ILS glidepath transmitter incorporates a sloping beam projecting 15 mi into approach area. Planes can be flown down on the beam precisely by pilot or ground control

ILS cockpit indicator. At top center, cross needles at right angles show plane is "on course"



Below at left is high pressure burner head with injector (Babcock & Wilcox design) for FIDO, the fog dispersal system. At right is a view of the system, the fifth basic installation at Arcata, in action





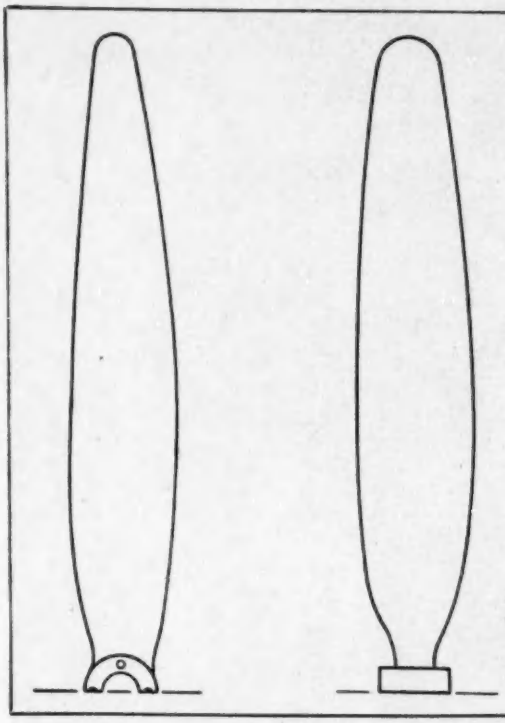


Fig. 1 – Blade designs – 85 hp, 6 ft, 2 in. diameter – left: fixed-pitch wood, activity factor = 70, H/B at $0.75R = 0.130$; right: controllable pitch, activity factor = 90, H/B at $0.75R = 0.061$

LOW-PRICED PROPS for

FROM PAPERS* BY

JOHN F. HAINES

Director of Research, Aeroproducts Division, GMC

(Mr. Haines' Wichita paper will be published in full in SAE Quarterly Transactions*)

MANUFACTURERS of propellers for personal aircraft could meet 90% of the requirements for some time to come by concentrating on a 2-position automatic propeller for engines up to 150 hp and a constant-speed propeller for the 150-250-hp range. They should also direct their efforts toward reducing costs, with their goal set at $1 per hp for the basic designs, which should not be complicated by provisions for feathering or reverse pitch.

Actually these generalizations may have to be modified in some cases, for many compromises are necessary to balance weight, cost, safety, performance, pilot skill, maintenance, and other factors.

Performance itself is composed of many factors, but fortunately there are only two flight conditions in conflict, namely, low-speed operation, which includes take-off and climb, and the high-speed conditions involving maximum speed and cruise. In other words, the best propeller for take-off is also nearly the best for climb. The same holds true for cruise and maximum speed.

For this reason – and because the private owner is probably most interested in them – only take-off and cruise characteristics are considered in this discussion.

Three types of aircraft are discussed: a 2-place airplane typical of those having low wing loading and relatively high power loading; and a 4-place aircraft typical of those with higher wing loading and lower power loading. Table 1 gives the specifications for these aircraft. A larger, multiengine aircraft will also be mentioned briefly.

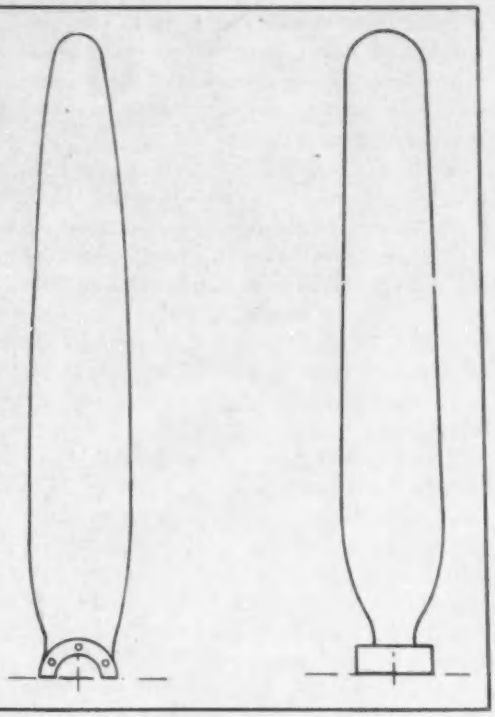
Table 1 – Airplane Specifications

	2 Place	4 Place
Span, ft	31	33
Engine Horsepower	85	185
Gross Weight, lb	1400	2550
Empty Weight, lb	800	1480
Power Loading, lb per hp	16.5	13.8
Wing Loading, psf	9.0	14.1
Landing Speed, mph	45	55 (flaps)
Fuel, gal	25	40

The effect of the conventional, fixed-pitch wood propeller, the 2-position controllable propeller, and

*Paper, "Propeller Requirements for Light Aircraft," was presented at the SAE Annual Meeting, Detroit, Jan. 6, 1947, and "Better Propellers for Light Pocketbooks" was presented at the SAE National Personal Aircraft Meeting, Wichita, Kans., May 1, 1947.

Fig. 3 – Blade designs – 185 hp, 7 ft, 4 in. diameter – left: fixed-pitch wood, activity factor = 85, H/B at $0.75R = 0.120$; right: controllable pitch, activity factor = 94, H/B at $0.75R = 0.060$



LOW-PRICED PLANES

the constant-speed controllable propeller will be considered.

The characteristics of the propellers used with the 2-place airplane are shown in Fig. 1 and the performance characteristics are compared in Fig. 2. Low-speed characteristics are considered in terms of take-off run necessary to clear a 50-ft obstacle at sea level in still air.

Cruising performance is considered in terms of cruising speed and fuel consumption in gal per hr at 75% rated power. The fifth bar on the latter condition describes the No. 4 engine and propeller combination at 60% of its rated power, which gives the same cruising speed as that obtained by the best of the other powerplants, that is, No. 1. The fuel consumption for this cruise condition is slightly higher than the optimum combination with the lower hp engine.

Fig. 2 indicates that little sacrifice in range need be associated with the higher powered engine. Here, however, we run into one of the snags that so frequently trips up the engineer. Unfortunately,

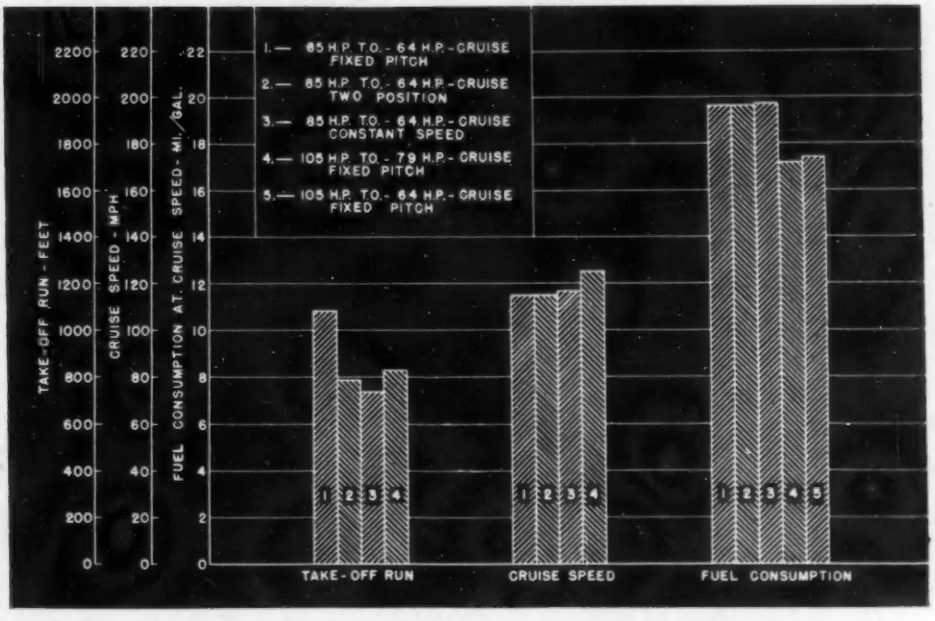

1.— 85 H.P. T.O. - 64 H.P. - CRUISE FIXED PITCH
2.— 85 H.P. T.O. - 64 H.P. - CRUISE TWO POSITION
3.— 85 H.P. T.O. - 64 H.P. - CRUISE CONSTANT SPEED
4.— 105 H.P. T.O. - 79 H.P. - CRUISE FIXED PITCH
5.— 105 H.P. T.O. - 64 H.P. - CRUISE FIXED PITCH
TAKE-OFF RUN - FEET
CRUISE SPEED - MPH
FUEL CONSUMPTION AT CRUISE SPEED - MI./GAL.
TAKE-OFF RUN
CRUISE SPEED
FUEL CONSUMPTION

Fig. 2 – Performance characteristics for 2-place airplane

airplanes are still flown by pilots, and pilots have minds of their own. Few pilots having at their command more cruising power can refrain from using it, so the actual cruise consumption is more nearly that shown by No. 4.

Fig. 3 shows the blade characteristics of the propellers used in the 4-place machine. Fig. 4 shows the take-off and cruise characteristics. There is now somewhat more difference between the fixed-pitch and controllable pitch propellers, due to the generally higher airplane performance. The No. 4 combination requires an increase of 32% in engine power, which is manifestly impossible without a major airplane change, assuming a well-balanced design originally.

Two other types of controllable pitch propellers should be considered, the fully automatic propeller that maintains essentially constant speed for a given engine torque, and the manually controllable selective pitch type in which the pilot may select any blade angle within the range of the propeller. The performance of the fully automatic propeller is nearly the same as that of the controllable constant-speed propeller except that cruise fuel consumption is slightly higher, because cruising rpm is the same as for the fixed-pitch propeller. Actually, this reduction is negligible. The manually controllable selective pitch type has essentially the same characteristics as the constant-speed controllable propeller, assuming the pilot is sufficiently on his toes to maintain rpm constant with changes in air speed or altitude by continual manipulation of the propeller control. It assumes further a greater angle range than the 2-position type, otherwise it has the same characteristics as the 2-position propeller.

The fully automatic propeller has fundamentally the minimum number of parts, since it consists only of a hub, blades, blade retentions, and a mechanism to coordinate angles. This type, therefore, should cost least to make. Unfortunately, its complicated functioning makes it difficult for the average person to adjust, so that field service would be required, and it is sensitive to friction anywhere in the system – factors that would be reflected in the final cost.

Next in order of decreasing simplicity comes the addition of a simple forcing mechanism to bring about pitch change. By using rpm as the controlling variable it is possible to preserve the automatic operation without needing controls to the cockpit or connection with the engine. Friction is less critical than with the thrust-sensitive type of fully automatic propeller, operation is a little more straightforward and easier to understand.

Next comes the controllable servo-operated type, which has, in addition to the hub, blades, and blade retentions, a pitch changing mechanism controllable by the pilot. This class is functionally simple, straightforward in design, and easy to understand, so that the cost of maintaining satisfactory operation in the field would be low.

Controllable constant-speed propellers are the most complicated mechanically, particularly if an external governor is added to one of the 2-position or selective types. By building the governing system directly into the propeller the number of parts can be reduced and installation made no more difficult than with the simple controllable type.

Weight

Detailed design and materials of construction will have more effect on the overall weight than will the type of operating mechanism selected. Current designs run as high as 75% more in weight than fixed-pitch wood ones, the increase, in gen-

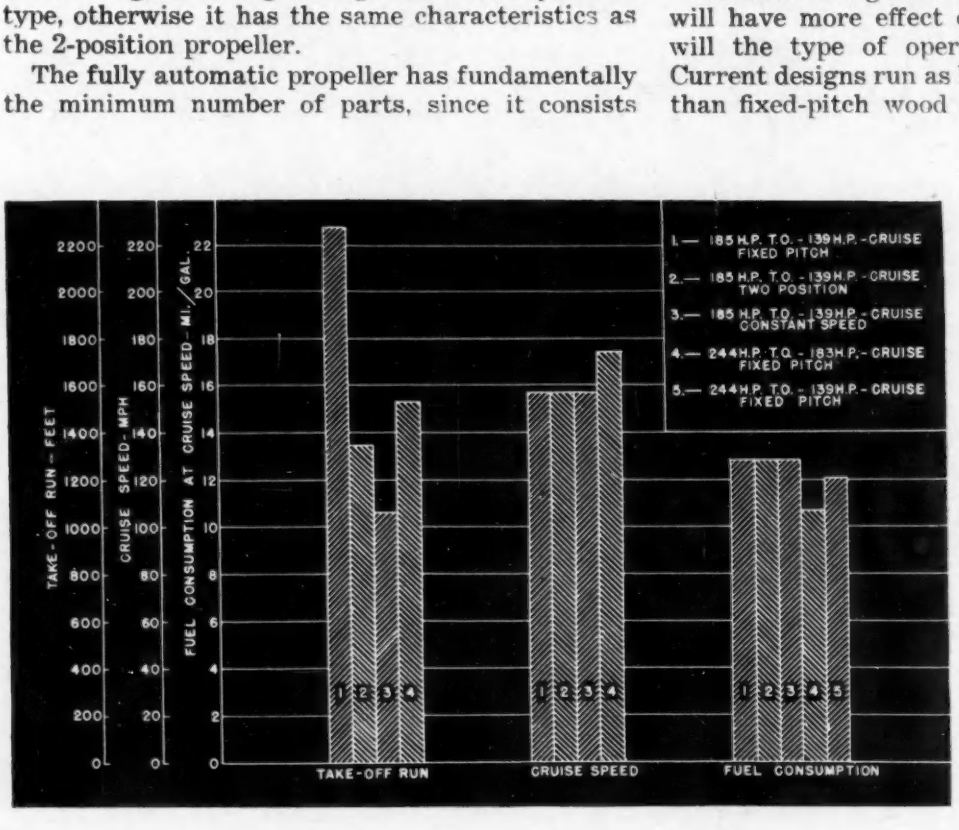

TAKE-OFF RUN - FEET
CRUISE SPEED - MPH
FUEL CONSUMPTION AT CRUISE SPEED - MI./GAL.
1.— 185 H.P. T.O. - 139 H.P. - CRUISE FIXED PITCH
2.— 185 H.P. T.O. - 139 H.P. - CRUISE TWO POSITION
3.— 185 H.P. T.O. - 139 H.P. - CRUISE CONSTANT SPEED
4.— 244 H.P. T.O. - 183 H.P. - CRUISE FIXED PITCH
5.— 244 H.P. T.O. - 139 H.P. - CRUISE FIXED PITCH
TAKE-OFF RUN
CRUISE SPEED
FUEL CONSUMPTION

Fig. 4 – Performance characteristics for 4-place airplane

SAE PROP STANDARDS

Now in process of development are SAE standards for tapered propeller shaft ends and flange ends of various sizes to be used with low-horsepower aircraft engines. These standards will cover both wood and metal propellers.

eral, being a little more for the smaller units. When the recently developed structural materials of extremely high strength-to-weight ratios are adapted to propeller blades, it should be possible to build a constant-speed controllable pitch propeller for the 4-place plane with a weight increase of less than 10%. A 2-position automatic propeller for the smaller airplane appears feasible with a weight increase only slightly higher.

Safety

Safety is one factor that should not be compromised to reduce costs. The structural integrity of any propeller designed for personal aircraft must be ensured under all operating conditions, plus conditions involving reasonable abuse and mishandling. Pilots may become careless or may just plain forget which handle to pull in moments of stress. Major structural failure in the propeller simply cannot be permitted.

Failures in the operating mechanism probably will never be absolutely eliminated. The mechanism can be so designed, however, that the blades assume an angle permitting continuation of flight when operating force is lost. For the 2-position propeller, operation at low pitch will reduce flight speed and range but will be safer if the pilot has to climb away from an unsuccessful landing approach. It requires some attention by the pilot to prevent overspeeding. Selective pitch or constant-speed propellers should also go to low pitch if the mechanism fails, but part-throttle operation is even more necessary to prevent overspeeding.

There is little to be gained in cruising performance by using controllable pitch. Some improvement can be made by using better blade design, since we must compromise cruising efficiency less in favor of take-off and climb. Thinner sections can probably be used because torsional stiffness is somewhat less of a problem. Propeller diameter can often be reduced with a slight improvement in cruising performance without too serious loss at low speed, although this is not always the case. Cruising performance of any given design is primarily a function of the aerodynamic characteristics of the design and the engine power.

Present engine prices are about $4.50 per hp and up. It is difficult to estimate additional cost of such items as structure and tankage associated with an increase in power, but let us assume that it brings the total cost per hp increase up to about $5. For the smaller plane a 24% increase in engine power was needed to get about the same improvement in take-off as given by the controllable propeller. The propeller cost that gives the same net cost increase to the manufacturer for the same take-off improvement is $1.20 per hp more than the fixed pitch, or about $1.45 per hp total. For the larger airplane where engine costs are a little higher (assumed $6) and power increase is 32%, the corresponding cost is $2.15 per hp.

The private owner must consider not only first cost but engine maintenance, which increases almost in direct proportion to engine power. Maintenance of a controllable propeller, however, should be considerably less per unit of performance than the additional maintenance on a higher powered engine.

The problem of controllable propellers for small, twin-engine aircraft is similar to that for single-engine aircraft except that it may be necessary to be able to feather one propeller during engine failure to permit safer single-engine performance without excessively large engines. Although the drag of the dead engine of a larger plane of higher performance would be critical, it is not generally true of the small engines we are considering, so that feathering would probably not be worth the cost in these sizes.

PRECISION CASTING

cont. from p. 40

With present materials and carefully developed techniques, a large variety of such precision castings are already being made which have replaced other methods of manufacture at considerable savings. Due to the development of low density metal casting plasters, plaster molds may not economically compete with sand casting particularly where the sand casting must be machined.

Combined Methods can frequently be of optimum utility. When the production advantages of the die casting or permanent mold casting method can be combined with the design advantages inherent in the investment or plaster molding method, this is true. In general, the method is to make a die or permanent mold and insert a ceramic or plaster core after which the cast is made in the conventional manner, casting either statically, centrifugally, or under pressure.

With some designs it is difficult or impossible to make the plaster core in one piece due to the back draft, in which case the core may be broken down into castable units and assembled into the permanent mold. In the past, sand has been used for the core material but it did not give the desired dimensional tolerances nor the surface finish to the casting. The use of plaster cores in permanent mold offers a large field in precision casting.

. . . . . ENGINE WARM-UP

BASED ON A PAPER* BY

J. G. MOXEY, JR.

Assistant Chief Engineer, Automotive Section
Development Division, Sun Oil Co.

(This paper will be published in full in SAE Quarterly Transactions)

PERFORMANCE of today's fuels and automobile engines during the warm-up period shows:

- **An appreciable variation in performance is obtained with any given fuel;**
- **Mechanical deterioration of the powerplant through use effects changes which impair its original warm-up performance;**
- **The "average 65% point"[1] is a fairly good measure of the fuel's warm-up ability, because a fuel's volatility has an important effect on warm-up performance, and**
- **Automobile manufacturers should recognize the fact that the amounts of high boiling, high octane gasoline fractions produced by refining equipment installed during the war has increased. Hence they should expect a lowered volatility of gasolines.**

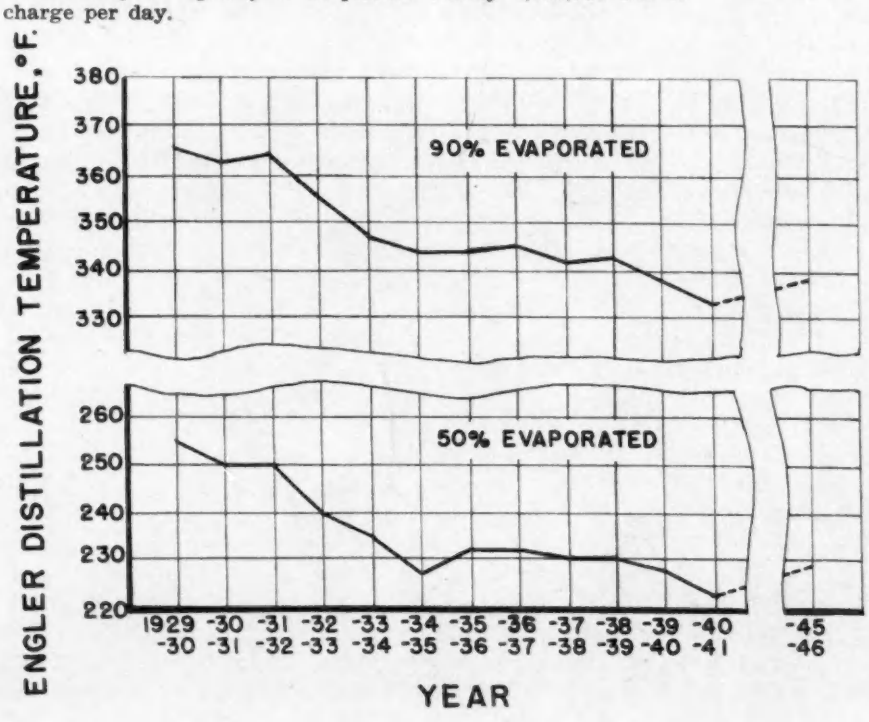
These conclusions are based on a study of engine warm-up with present-day fuels and engines, to appraise the economics of gasoline manufacture in view of wartime changes in refining.

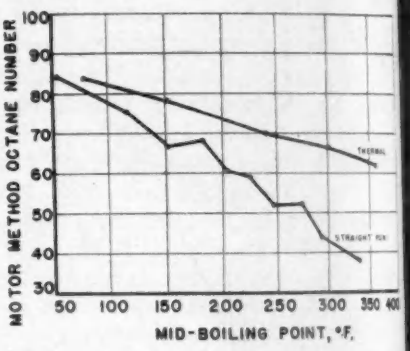
This work was done during the past winter, and these charts point to why and how these conclusions were reached.

*Paper "Engine Warm-Up with Present-Day Fuels and Engines," presented at the 1947 SAE Annual Meeting, Jan. 9, 1947

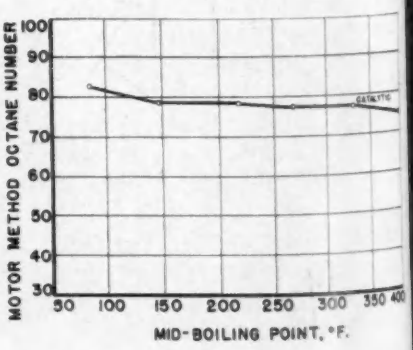
[1] Average of the 40 through the 90% evaporated points from an ASTM distillation.

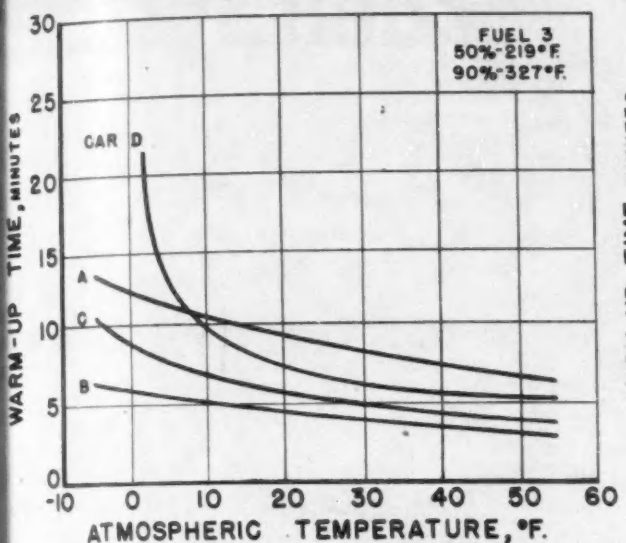
During the prewar period the mid-volatility shows a continuous trend toward a lighter, more volatile gasoline (below). A similar chart would show that, during the same period, there was a continuous rise in antiknock quality. Because one method to increase antiknock quality was to produce a lighter, more volatile gasoline, these two trends are related. Refiners, during that period, cut out the high boiling, low octane fractions to improve antiknock quality. Note that this trend has reversed since 1940. Nearly all large refineries have now installed catalytic equipment as a result of the war's need for aviation fuels; total catalytic capacity is at present nearly 1,000,000 bbl of charge per day.



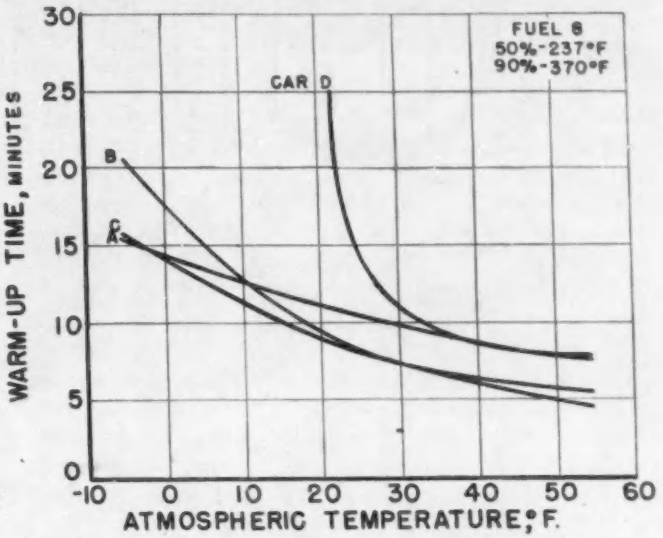


Relationship of the trends shown at the lower left are exemplified in the above chart which shows the distribution of antiknock quality throughout the boiling range of typical straight-run and thermally cracked gasolines. The curve below is similar to that above. It shows the distribution of antiknock quality throughout the same temperature range of typical catalytic gasoline.



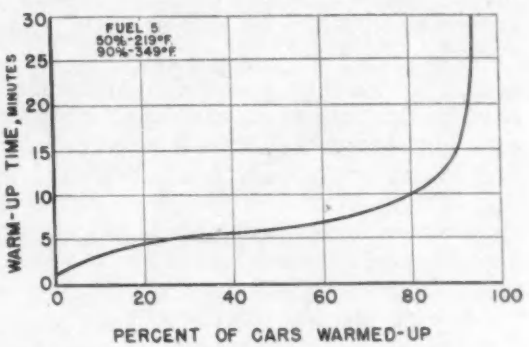


Warm-up characteristics of today's cars using present day fuels are shown in the two charts above. At the left the fuel had a 50% point of 219 F and a 90% point of 327 F, a gasoline considerably more volatile than the average winter grade marketed 1945-46. Warm-up time increases as atmospheric temperatures decrease. Some cars digest fuel better than others, and some are more sensitive to atmospheric temperatures.

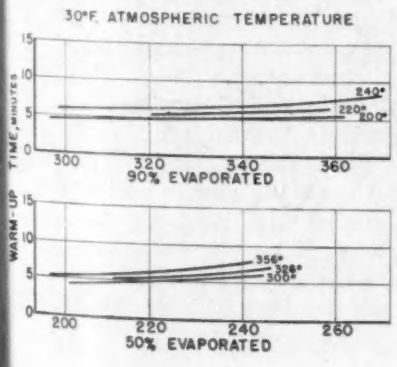


With a less volatile fuel, the same cars reacted as shown in the above chart. The fuel had a 50% point of 237 F, and a 90% point of 370 F. Warm-up time increased generally with this heavier fuel, which was somewhat heavier than the 1945-46 winter average, although within the commercial range. Car D was unable to warm-up satisfactorily at temperatures below 20 F, and their relative positions were rearranged here.

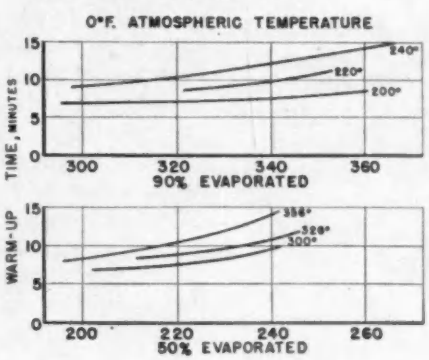
Twenty-eight cars, taken off the road, using a fuel of average volatility at 30 F atmospheric temperature, showed warm-up characteristics as plotted at the right. Their owners considered they operated satisfactorily, and they were not altered prior to the testing runs.



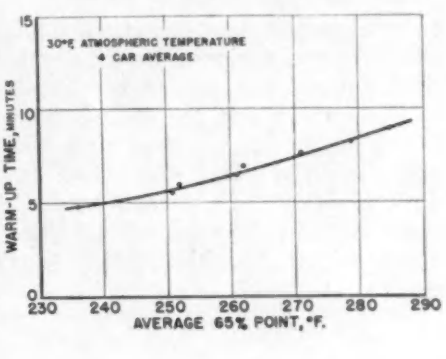
Relative effect of 90% and 50% points at an atmospheric temperature of 30 F are plotted below. Cars A, B, and C were averaged because Car D was unable to warm up satisfactorily on a number of the fuels at the lower temperatures.



At zero temperature, the same three cars averaged as shown below. This, and the chart at the lower left, show that the 50% point is about twice as effective as is the 90. A change of 1 F in the 50% point of a fuel equals 2 F in the 90% point.



Agreement between experimental data on warm-up time and the average 65% point for the eight fuels is shown below. The correlation is reasonably good. Plots of the individual cars at various temperatures give correlations on the order shown.



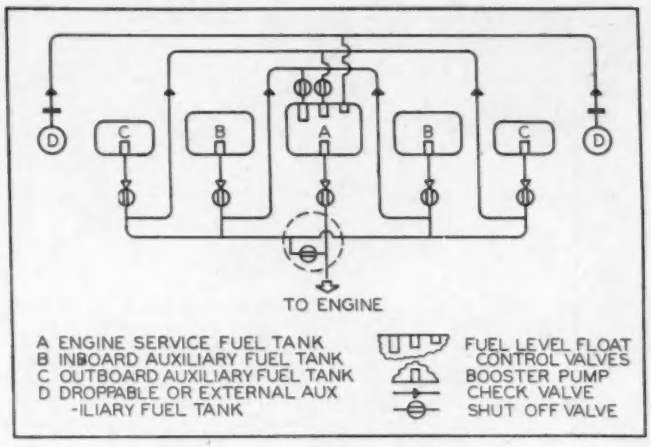


Fig. 1 – Diagram of fuel system for single-engine aircraft

Fuel Systems fo

FROM A PAPER* BY

W. H. Curtis and W. J. Lansing

THOMPSON PRODUCTS, INC.

AIRCRAFT fuel systems for gas turbine powerplants must satisfy all the old requirements plus some new ones. Fuel must be delivered from the tank all the way to the fuel nozzles of the burner, not simply to a carburetor. Rate of fuel delivery must be regulated according to conditions of engine rpm, ambient air pressure, and perhaps turbine temperature. And, like other aircraft engines, the gas turbine must have an emergency fuel system to take over in case of damage to the main system.

The gas turbine powerplant demands that fuel flow be continuous although, at high speeds and high temperatures, it may have to vary by as much as 75% during short time intervals. The whole fuel system should be precise in its responses and absolutely reliable. Engineers are aiming at making its operation more and more automatic in order to lessen the pilot's duties. This adds new fuel devices to an already complicated system.

In the airframe outside the powerplant, the fuel system consists of tanks and booster pumps. Inside the powerplant are located filters, pumps, controls, and nozzles. Besides this regular system, there are selector and shut-off valves and a pump to form an emergency system. Figs. 1 and 2 are diagrams of fuel systems for single-engine and two-engine installations.

Each powerplant has its own engine service tank filled from a series of auxiliary tanks. Automatic float valves are preferred to pilot-controlled selector valves for regulating flow from auxiliary tanks to the engine tank under normal operation. The order in which the tanks empty, determined during design, is according to stress and trim specifications. The switching should be completely automatic to provide continuous flow.

* Paper "Study of Fuel Systems for Jet Aircraft," was presented at SAE Annual Meeting, Detroit, on Jan. 7, 1947.

Cutoffs are needed to close the fuel lines from disposable tanks as they are dropped.

Tanks and Booster Pumps

Booster pumps are needed in all auxiliary fuel tanks except those externally mounted. (Fuel may be forced from externally mounted tanks by air pressure.) At the high rates of climb possible with gas turbine powerplants, either booster-pump discharge pressure or capacity or both may be seriously reduced.

The higher the rate of climb, the more vigorous the boiling of fuel as it reaches its critical altitude. Fig. 3 shows critical altitude versus temperature for fuels ranging from 1 to 12 psi true vapor pressure. The rate of emission of dissolved air increases with rate of climb also, so that booster pump operation may be faulty even before the critical altitude is reached.

Permitting the tank to become pressurized is one way to hold down its equivalent rate of climb. This is usually done by using a back pressure valve which remains closed until some limiting pressure differential between the tank and ambient air is reached.

For example, if the pressure differential required to open such a valve is 4 psi, the equivalent rate of climb within the tank will be zero until an altitude of 8500 ft is reached. There the ambient air pressure is 4 psi below sea level pressure, which has been maintained in the tank.

Between this altitude and the critical altitude, the rate of climb within the tank will correspond roughly to that of the airplane. Beyond the critical altitude, where the fuel begins to boil, the equivalent rate of climb within the tank depends on the rate of climb of the airplane, diameter and length of the vent line, and the rate of cooling of the fuel that would be caused by loss of heat through the tank walls without boiling effects.

for JET AIRCRAFT

Provision ought to be made for uninterrupted fuel flow, at least for a specified period of time, at any operating altitude of the airplane.

Besides all the other variables, booster-pump operation is affected by the size and shape of the fuel tank and the depth of fuel above the pump inlet. Because there are so many variables, laboratory tests on mock-ups of the fuel system outside of the powerplant are essential in designing any installation.

Better Filters Needed

Fuel enters the engine through a filter. Pumps and controls within the engine are assembled with very small operating clearances. Without a filter, the units would be quickly jammed by foreign matter in the fuel.

Filters capable of retaining particle sizes as small as 10 to 25 microns have been used, but they are bulky and easily clogged. Duplex filters, having a standby element which automatically takes over when the regular element becomes inoperative, have been found too heavy and bulky. In some installations, when the pressure drop across the filter exceeds 2 psi, the filter is bypassed leaving the rest of the fuel system unprotected. None of these arrangements is really satisfactory. There is a great need for an improved filter.

Engine-Driven Pumps

The fuel is led to the engine-driven fuel pump from the filter. Two types of pumps have been used so far, and each has its disadvantages. Variable-displacement pumps have been the more successful, although they are bulky and complex. Fixed-displacement pumps are simpler, but the gearing by which they are usually driven has a short life, particularly with fuels of high vapor pressure.

The variable-displacement pump uses a wobble plate which actuates coaxial pistons. The stroke of the pistons can be changed to suit fuel delivery requirements. Fuel flow is regulated by means of a variable oil pressure. In some cases, the oil pressure is controlled by engine rpm or temperature. In other cases the pilot has a manual control for the oil pressure. Then the oil pressure governs fuel flow, which is used in turn to regulate engine rpm and temperature.

Control oil for variable-displacement pumps comes from the powerplant tank, and the pressure is supplied by a small oil pump built into the fuel pump. Circulation of this lubricating oil can lengthen the life of the fuel pump. However, it has caused some cavitation trouble.

This occurred when hot oil – the oil circulates through the accessory-drive section also – lost some of its heat to the fuel in the pump. Cavitation is most likely to occur with high-altitude operation, where the rate of fuel flow is low. It will certainly cause trouble when a fuel of 7-psi vapor pressure is used. A logical solution to the cavitation problem appears to be provision for cooling the control oil before it is supplied to the fuel pump.

Fixed-displacement fuel pumps have no control-oil system, but they do require a relief valve to care for excess fuel pumped during periods of operation when the engine demand is low. The relief valve sends the excess fuel back to the pump inlet, sometimes at high pressures.

Considerable heat is evolved, so that high temperatures at the pump inlet may cause vapor lock or cavitation. These difficulties can be lessened at extreme altitudes by incorporating an altitude element in the relief valve. With the altitude element, the relief valve passes fuel back to the pump inlet at lower and lower pump pressures as altitude increases. High pump pressures are not necessary at altitude anyway because fuel flow is low. The lower pressure makes it easier for all controls to function at low fuel rates.

Even with the altitude element in the relief valve, there may be a sufficient temperature rise in the recirculated fuel to cause malfunctioning of the pump

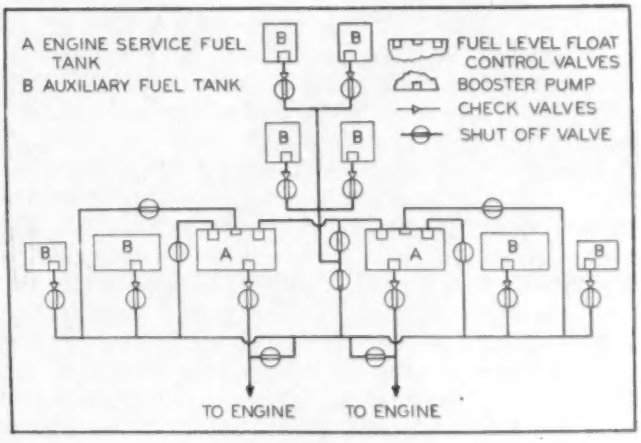


Fig. 2 – Diagram of fuel system for two-engine aircraft

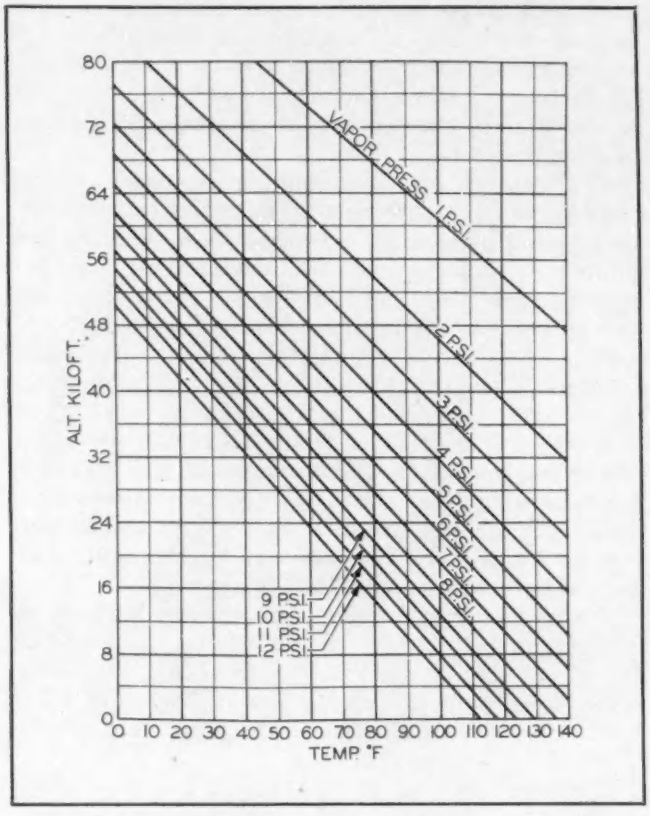


Fig. 3 – Critical altitudes for fuels having various vapor pressures

with fuels having vapor pressures appreciably higher than that of kerosene.

Cooling of the recirculated fuel might be a cure, but it would increase drag as well as space required and weight.

Controls

American designers feel that fuel flow and pressure should be regulated in accordance with engine rotational speed, turbine temperature, and ambient air pressure. The British and Germans haven't been using temperature bias but agree on the need for engine-speed and altitude-pressure controls.

Governors regulate engine rpm by varying fuel pressure. The speed-sensing ability of the governor must be sharp, but the changes in fuel pressure made by its control unit must be gradual. Otherwise, the control will quickly cut down on fuel when the turbine overspeeds, then respond immediately with an increase in fuel as the turbine speed drops. The governor is a hunting device which may result in unstable, cyclic operation unless some damping is provided in the mechanism.

The amount of damping needed in the governor mechanism depends on the self-regulating characteristics of the turbine. Turbines of turboprops tend to be more strongly self-regulating than those of turbojets.

Thermal controls limit the mixture leaving the burner to temperatures the turbine blades can stand. Here again cyclic response must be avoided, but the bigger problem is to find a temperature-sensing device which will act fast enough. A lag may reduce fuel too late to prevent damage to turbine blades as temperature climbs, and increase fuel too slowly to keep up power as temperature recedes. Electronic devices will probably be superior to mechanical thermostats in regard to lag characteristics.

On the German Jumo 004, a choked servo motor was used instead of a temperature-sensing device to hold the rate of fuel-flow increase to predetermined limits. Some engines in service have no thermal control at all, but engineers now feel that protection is undoubtedly needed.

The ideal location for the temperature-sensing device would be on the turbine blading, but it is impractical to install it there. The elements are installed in tail pipes in some powerplants now used. Many engineers believe a better location would be immediately downstream of the turbine blading, nearer to the parts to be temperature-protected.

Because the powerplant's need for fuel is smaller at higher altitudes, an altitude compensator is sometimes included in the control group. Its job is to vary fuel pressure with barometric pressure. It appears that the best way to apply the control is to have it change the equilibrium position of the rotational-speed governor. The governor then exercises normal control over fuel pressure, but as altitude increases, the governor maintains a given engine rpm at a lower fuel pressure.

There is also a need for a control that will function on fuel-air ratio to prevent flame blowout at very low fuel rates or at extreme altitudes.

Flow Dividers and Nozzles

In those gas turbine powerplants having multiple combustion chambers or nozzles, distribution of the fuel to the individual unit is as much of a problem as distribution of fuel to the various cylinders of a piston-type engine. Some sort of flow divider which will insure a uniform rate of fuel flow through all nozzles is needed. None has been developed yet as far as we know.

Two production nozzles of the same design seldom have the same pressure-drop characteristics. The flow divider should be capable of compensating for these inequalities over a range of fuel temperatures and viscosities.

The fuel nozzle is the final element of the system delivering fuel to the powerplant. Its delicate passage should be protected from foreign particles by installation of a filter immediately upstream of the nozzle. No fixed-orifice nozzle has been found which will accommodate the various flows and pressures required by the engine and still produce a good spray pattern.

The best nozzle appears to be one which will re-

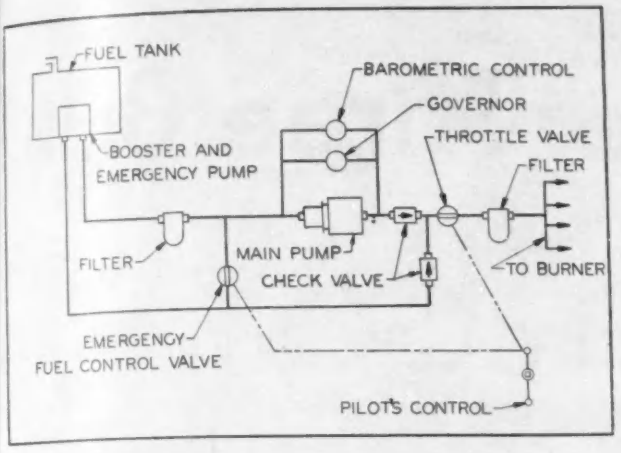


Fig. 4 – Fuel system with dual-purpose booster pump for emergency

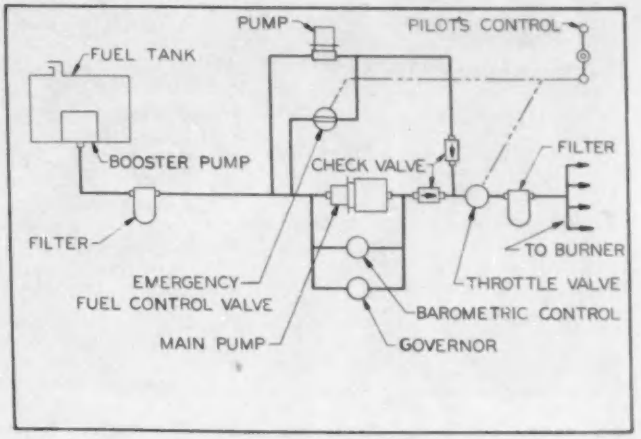


Fig. 5 – Fuel system with electric motor-driven emergency fuel pump

duce its aperture to operate on some minimum pressure at low flows and open to operate at whatever maximum pressure may be required by a particular engine. On the low side, the opening and closing must be extremely sharp to prevent dribbling. Of course, the controls of such a nozzle will be one more tough problem for the fuel-system engineer to work out.

Emergency Fuel System

Just what is required of an emergency fuel system has not been decided yet. Some of the questions raised are:

1. In case of failure of the main fuel system, what type of engine operation becomes acceptable? In other words, must duplicate engine-speed, turbine-temperature, and altitude-compensation controls be provided in the emergency system?
2. What weight penalty is acceptable for emergency fuel system installations?
3. Should the pilot be warned of fuel system failure and given the job of switching to emergency operation, or should the switch-over be fully automatic?
4. If the switch-over is fully automatic, how can the pilot be informed of the fuel-system failure so that he can check dangers resulting from fuel leakage?

The authors feel that a duplicate control system is essential, but it must be light in weight. The operation of the entire fuel system ought to be automatic. Nevertheless, failures and their locations in the main system must be brought to the pilot's attention so that he can judge whether operation should be continued.

Complete duplication of the main fuel system for emergency use is prohibited by weight considerations. Two emergency systems which have been used are diagrammed in Figs. 4 and 5. The method shown in Fig. 4 uses a dual-purpose pump in the engine service fuel tank. Normally the pump operates at low pressure as a booster pump, but it can be switched to high pressure operation in case the engine main pump breaks down. The arrangement shown in Fig. 5 employs an emergency fuel pump installed in the engine fuel system and driven by an electric motor. In both cases, the pilot makes the change from the main to the emergency system by means of a manually-operated switch. Then he must control the pump output manually.

Two additional safeguards for incorporation in the emergency system are proposed: automatic means for maintaining fuel feed to the engine in case of booster-pump failure, and automatic means for maintaining feed in case of damage to the engine service tank.

Without the second provision, it would be possible for the float valves in the service tank to empty overboard all of the fuel from auxiliary tanks in an effort to supply the service tank. The pilot might not be aware of trouble until the engine cut off due to lack of fuel.

Kirchner's Review Is Now Available

The comprehensive "Review of Air Transport Developments for the Year 1946," by Otto E. Kirchner, director of aircraft engineering, American Airlines, Inc., is now available in preprint form from the SAE Special Publications Department.

With its 39 pages of text, the paper is copiously illustrated and reviews SAE Meetings papers on this subject which were presented at various meetings of the Society during that year.

Special attention is being called to the paper's availability at the request of the Publication Committee.

Copies of the paper are available at 25¢ to SAE members and 50¢ to non-members.

Three Bus-

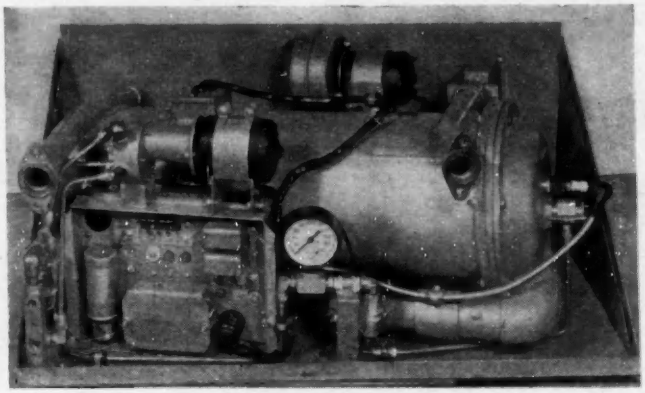


Fig. 1 – Auxiliary heat, such as that provided by this fuel-burning booster heater used in GMC transit coaches, is the answer to satisfactory heating since engine heat alone is not sufficient under all conditions

BASED ON A PAPER* BY

E. T. Todd

and F. O. Gadd

GMC. TRUCK & COACH DIVISION

(This paper will be published in full in SAE Quarterly Transactions)

AUXILIARY heat surpasses rejected engine heat as a means of heating motor buses since it produces correct temperature, freedom from odors, and clear glass in the vehicle. GMC transit coaches satisfy these three heating system musts with a booster heater.

Inadequacy of engine heat creates complaints of extreme or varying temperatures, obnoxious odors, and hazardous fogging or icing of windows.

Designers relying on engine heat alone resort both to recirculation of enclosed air to conserve heat and to sealing of bodies to prevent infiltration of cold air. Recirculating air increases the amount of moisture in the passenger space beyond the saturation point since each occupant gives off from 1/4 to 1/3 lb of moisture per hr.

Moisture in excess of the saturation value condenses as fog or dew. Highly saturated warm air contacting cold window glass releases that quantity of moisture above the saturation point of the temperature resulting from contact with the glass. (Saturation-point moisture content of air decreases with decrease of temperature.)

This results in fog or instantaneous frosting in sub zero weather.

Obnoxious odor is another product of inadequate heat since recirculated air accumulates organic matter – perceptible as odors – as it picks up moisture. Because air recirculation fails to pressurize the passenger space, engine fumes may leak in.

A third evil associated with recirculation of heated air is unsatisfactory temperature control. Heating load varies with sudden changes in passenger load, solar heat, and power output. Even with thermostatic control, temperature regulation is limited to heat loss through the body structure.

How are these undesirables eliminated? One simple process stabilizes temperature, eliminates odors and cold drafts, and keeps windows clear – supplying a minimum of 20 cfm per passenger of fresh air to which the correct amount of heat has been added prior to introduction in the passenger space.

The 20 cfm of air has been found to be the minimum needed to carry away infiltration of interior odors and prevent infiltration of exterior odors.

Continuous flow of 20 cfm of fresh air per passenger provides a conveyor for quickly adding or subtracting the required amount of heat. This method controls temperature within the passenger space. If the coach rapidly fills with passengers, the sun suddenly comes out from behind a heavy overcast, steep grades are encountered, or if high speeds occur, the heat balance is violently disturbed and these changes must be compensated for instantly.

Thermostatic control cannot compensate for cessation of heat supply – as in sustained low-speed driving – without quickly adding auxiliary heat to the rapidly moving air flow.

Because the coach engine provides enough heat only part of the time, General Motors incorporates in its transit coaches a fuel-burning booster heater, shown in Fig. 1. The heater package assembly is about 28 in. long x 17 in. wide x 13 in. high. The illustration shows the water-jacketed combustion chamber, fuel pump and motor, combustion air blower and motor, fuel and air lines, and controls.

*Paper "Automotive Space Conditioning," was presented at SAE National Transportation & Maintenance Meeting, Chicago, Oct. 16, 1946

Heating Needs Met with BOOSTER HEATER

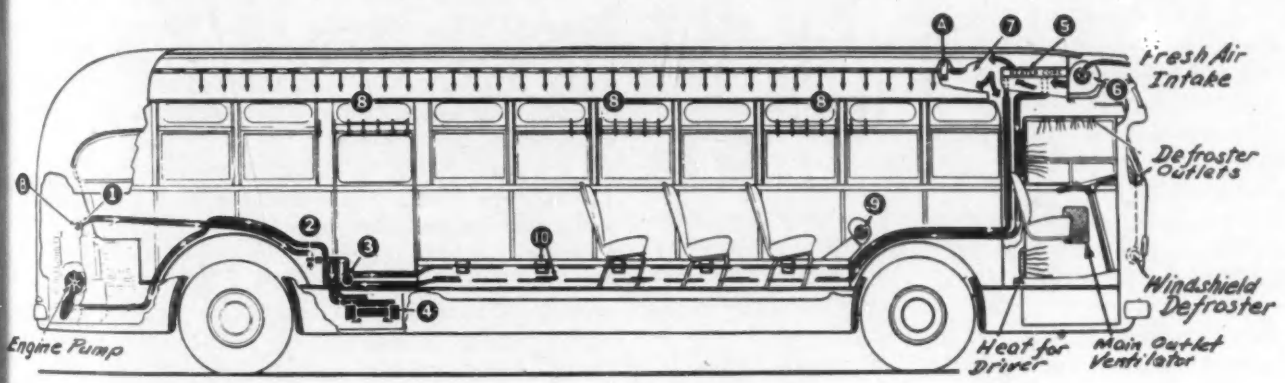
Fuel passes through a filter to the fuel pump. It is then carried to the nozzle through a pressure gage and solenoid cut-off valve. A return line from the fuel pump is directly below the fuel intake line. Fuel enters the combustion chamber at 100 psi and is ignited by the spark plug directly above it.

Water enters at the left end of the water jacket and flows around a thermal switch as it emerges from the right-hand outlet.

Air from the combustion air blower is piped under the water jacket and enters the cast combustion head directly under the fuel nozzle.

Space diagram of the GMC coach heating system is illustrated above.

Only with a fuel-burning booster heater is it possible to remove odors and maintain both clear windows and even temperature throughout the coach under widely varying operating conditions.

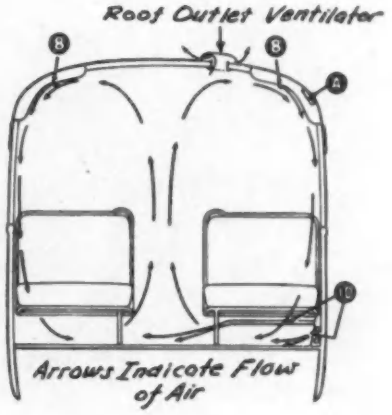


This heating and ventilating diagram of a GMC transit coach, equipped with a fuel-burning booster heater, No. 4, shows how air flow keeps the windows clear, eliminates odor, and maintains coach temperature.

Blower No. 6 draws air through the upper front roof panel. The air is then forced upward through heater core No. 5 and into air ducts along both sides of the coach, above the windows. Thermostat "A" maintains the air within the ducts at correct temperature. Heated air is distributed and discharged through slots No. 8.

Air discharge is downward over the windows. This air is dry, having moisture-absorbing capacity. In passing over the windows, it removes or prevents moisture accumulation on the glass.

Water flow is from engine manifold No. 1, through heater pump No. 2, and then through booster heater No. 4 and diversion valve No. 3. If thermostat "A" is satisfied, water flow is confined between engine and booster heater. When engine water temperature falls to a preselected minimum, engine temperature switch "B" ignites the booster heater and maintains operation until water temperature has reached the desired maximum.



(This paper will be published in full in SAE Quarterly Transactions)

Bus Rubber S
Triple A

BASED ON A PAPER* BY

F. R. Fageol

Chairman of the Board, Twin Coach Co.

TORSILASTIC suspension-equipped buses provide maximum passenger comfort and vehicle protection as well as long life and minimum maintenance by exploiting rubber's exclusive properties.

Rubber more nearly approaches the ideal suspension material than does alloy steel because:

1. It has substantially no initial friction to overcome in flowing and flexing and will last almost forever if flexed within its fatigue limits. Alloy steel will fail after flexing through just so many cycles, requiring replacement of the spring.

2. Rubber deflects through the cycle without permanent deformation. The familiar rubber band stretched to many times its original size retains its shape if its physical properties are not exceeded.

Properly designed, the rubber suspension system operates with nearly equal effectiveness under widely varying load conditions – an important feature to operators of cargo-carrying vehicles. Bus loads fluctuate from empty (during off-peak hours) to 100% seating and standing capacity (during rush hours). Despite the ratio of full to empty of as high as 2 to 1, the operator can expect about the same good ride.

Not so with alloy steel. Designed to carry a 10,000-lb load, for example, the steel suspension cannot give a good ride for both a 10,000-lb and 20,000-lb load. The vehicle rides well under only one of these load conditions, not both.

3. Rubber approaches the ideal in physical stability – unchanging suspension characteristics under extremes in temperature.

4. Rubber is not affected by salt, mud, water, and other materials that are detrimental to steel.

5. Present steel suspensions – in contrast with rubber – require constant maintenance. Either the springing or supporting member must be lubricated, kept tight, and retained in a state of good repair.

The Torsilastic spring not only uses the most ideally suited spring material, but it applies it to best advantage – in shear.

Rubber in compression does not produce an economical suspension because it requires more rubber per square inch than other methods. Rubber in tension is economically practical. But its load-carrying characteristics are such that a large amount of rubber must be used to gain sufficient capacity for a given job.

Only limitation to rubber in shear is the problem of keeping stresses low at the end of the shear plates. This is overcome in the Torsilastic spring by wrapping rubber in a circle and joining the ends. It eliminates high end stresses and allows higher unit stresses for a given amount of rubber.

Now to the application of the Torsilastic spring in a present-day bus that achieves sought-after passenger comfort and vehicle protection with a minimum of maintenance.

From a manufacturing and servicing standpoint, the shear rubber unit is best applied as both the springing member and radius rod or axle-locating device. In this case the spring unit consists of an inner tubular member, about 3 in. in diameter and 60 in. long, surrounded by a two-piece coaxial shell about 5 in. in diameter and 50 in. long. On the ends

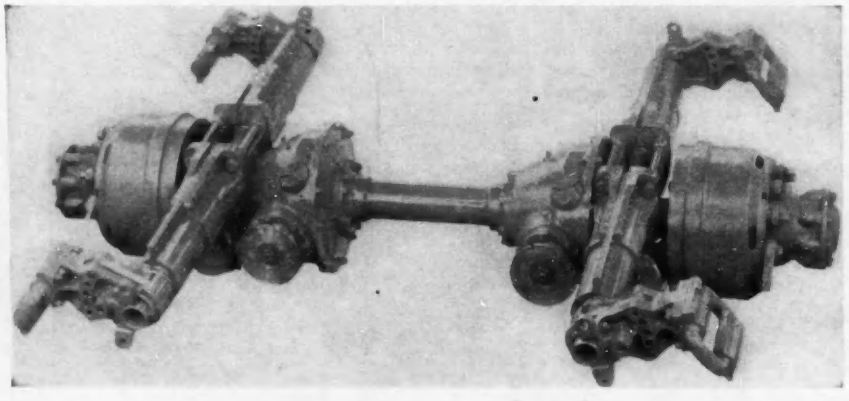
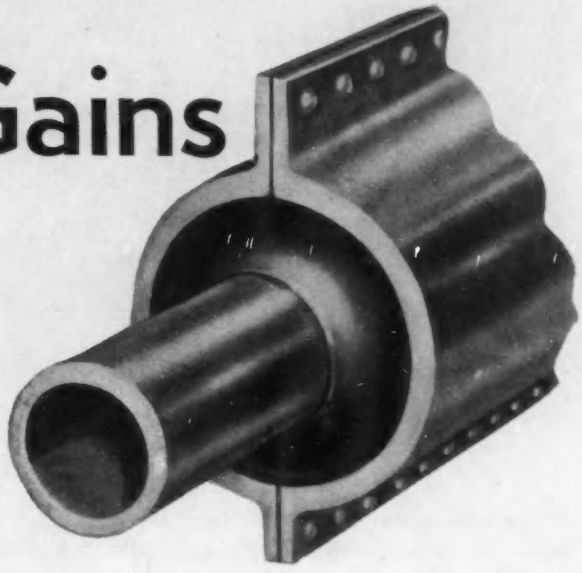


Fig. 1 – Twin Coach bus rear axle and spring assembly with the Torsilastic rubber shear unit

* Paper "A Rubber Torsilastic Suspension System," was presented at the SAE National Transportation Meeting, Chicago, on April 17, 1947.

Suspension Gains Advantage



of the inner member extending beyond the outer shell levers are applied.

Rubber separates the inner tube from the split two-piece outer shell and is vulcanized to both.

Levers welded to the inner tube extensions form part of the arm assembly, which is about 10 in. long. The units are identically used on each corner of the vehicle.

Two of these units are bolted parallel to each other on the axle housing or beam in the position normally occupied by a leaf spring. From a standing position directly over the axle and facing the vehicle front end, the arm assembly levers extend outwardly toward the body side at the front and rear ends of the spring unit, as in Figs. 1 and 2.

Rubber shackles in shear, shown in Figs. 3 and 4, connect the end of the lever to the body at a point approximately in line with the wheel center. Provisions are made in the lever for minor angular adjustment to compensate for changes in vehicle height and the slight initial set of the rubber.

This configuration permits use of conventional axles with but slight modification.

Suspending the vehicle in this fashion yields interesting mechanical results that fulfill the passenger comfort and vehicle protection aims.

The lever and shackle position is such that an increase in load deflects the vehicle downward, shortening the effective lever arm and rapidly building up spring resistance. This foreshortening action gives a substantially uniform spring deflection under any load so that the bus rides the same whether it carries one passenger or one hundred.

Hanging the body on shackle links produces a floating effect. The body tends to maintain a straight road course despite conditions forcing the axles to work under unstable cycles. Rubber shackles divorce direct load shock from the body by eliminating direct mechanical contact between the wheels and body.

In addition to lateral cushioning, rubber in the shackles offers appreciable fore and aft cushioning.

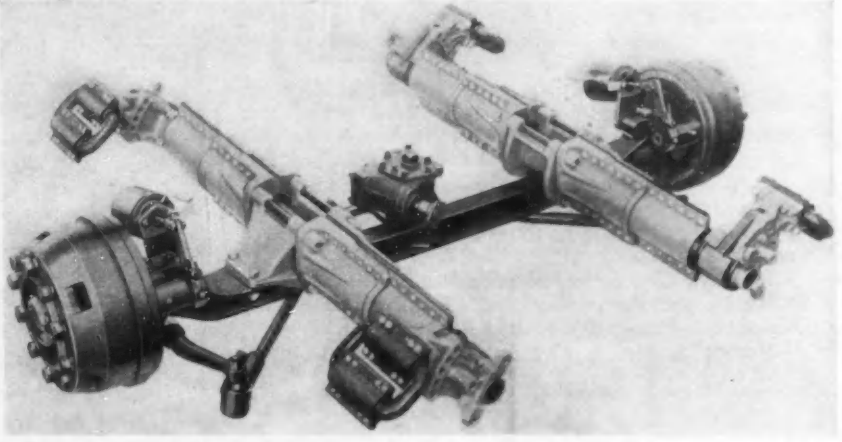


Fig. 2 – Front axle and spring assembly of the Twin Coach bus showing how the Torsilastic unit and lever assembly are bolted to the axle housing

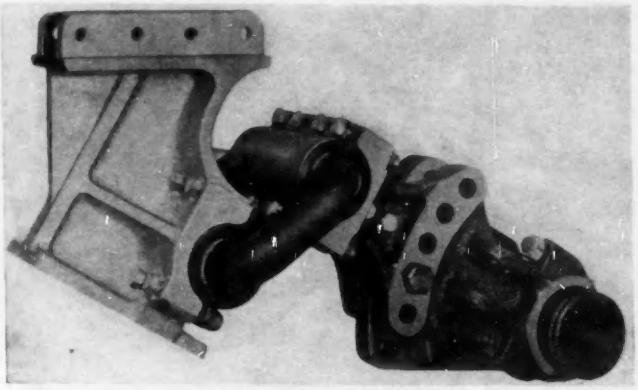


Fig. 3 – This rubber shackle connects the bus body to the suspension assembly

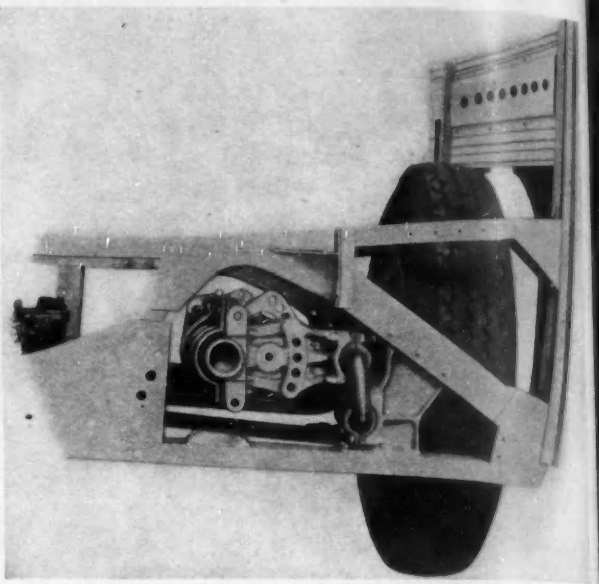


Fig. 4 – Hanging the bus body to rubber shackle links gives almost a floating ride. The rubber absorbs shocks normally transmitted from wheels to body in the case of direct mechanical contact

If the wheels hit a severe chuck hole or rail crossing, the axle actually floats, dissipating the shock load.

Resistance to vehicle swaying and rolling is greater than with any other suspension with the same spring rate, with or without special means to prevent it. Because of the suspension geometry, the vehicle actually swings inward – rather than outward – when rounding a normal curve so that passenger comfort is not disturbed.

Maintenance-wise this suspension is relatively trouble-free. The system requires no bearings or moving parts to lubricate and involves no units built to close tolerances. The suspension doesn't squeak or rattle. No possibility exists of abrasion, rusting, or wearing from dirt, road salt, mud, or any other condition encountered in normal vehicle operation.

Over a period of years this will save much in replacement and maintenance costs.

In a series of B. F. Goodrich Co. oscillation tests of 10 million cycles each to test durometer hardness of rubber in main springs and shackles, no main springs gave any indication of failure. While some shackle rubber showed signs of fatigue cracking after 6 million cycles, they didn't fail completely at the end of the test. Apparently there is no danger of sudden failure as might happen with a conventional system.

Engineers estimate these 10 million cycle tests are equivalent to 250,000 actual vehicle operating miles. If the vehicle operator can get a spring to hold up 300,000 to 500,000 miles as against the 75,000-mile life of alloy springs, he will gladly pay the higher initial price for the lower per-mile cost.

Equipping vehicle suspensions with the best-known practical elastic material – rubber – cushions the entire vehicle. The Torsilastic system permits the chassis to float without losing "feel" of the vehicle. Obviously this simple and relatively light-weight design satisfies the quest for greater riding comfort economically achieved.

Discussers Support Leaf Spring Merits

From Discussions

By Murray Fahnestock
Ford Field Magazine
and Walter F. Whiteman
William & Harvey Rowland, Inc.

IMPROVED leaf springs with good ride characteristics are still very much in the vehicle suspension picture, contend Fahnestock and Whiteman in rebuttal to Fageol's belief that rubber is outmoding steel springs.

Fahnestock takes exception to the claim that rubber will last almost forever. That rubber ages is evident in most rubber goods.

He labels incomplete Fageol's statement that a steel spring designed for 10,000 lb is not satisfactory for 20,000 lb while rubber rides equally well under both loads. That's a comparison of obsolete steel springs with modern rubber springs. Modern buses now are being equipped with progressive or variable rate springs that can be designed for any desired variation in rate.

Whiteman expands on this development by describing results with a three-stage variable rate leaf spring with vertical shackles and no shock absorber in one model car. It gives 65 oscillations per min with one passenger and 64 oscillations per min with five passengers as opposed to 83 and 70 oscillations per min, respectively, for the same loads with a constant rate spring.

He says dealers and owners of this vehicle claim it to be the best-riding and handling car on the road, both empty and loaded.

Recent developments, he adds, have made interleaf friction both noiseless and constant.

Plane Designer's Guide to 75ST ALUMINUM USES

EXCERPTS FROM A PAPER* BY

George Snyder and Frank J. Crossland, Boeing Aircraft Co.

Staff Engineer, Structures Structural Development Engineer

THE new high-strength aluminum alloy, 75ST, can be used in certain aircraft structural applications to save weight or increase strength, or both, over designs using other alloys. However, the structural engineer should be well acquainted with the advantages and limitations of 75ST before utilizing it in design.

The metal 75S is a wrought zinc-magnesium-copper alloy of aluminum whose maximum physical properties are obtained by a solution heat-treatment followed by artificial aging (precipitation heat-treatment). It contains approximately 5.75% zinc, 2.5% magnesium, and 1.5% copper as the principal alloying elements.

Mechanical Properties

Minimum properties for 75ST and 24ST are shown in Table 1. Compared with 24ST alclad, which has been the standard aircraft material, 75ST alclad is approximately 16% stronger in ultimate tension and 8% stronger in ultimate shear.

However, the most significant gain is in yield strength for both tension and compression which, in the "T" condition, is approximately 55% greater than the 24ST yield strength. The ultimate bearing is approximately 14% greater than 24ST and the elongation is approximately two-thirds of the value for 24ST.

Metallurgical Properties

The grain structure of 75S is, in general, similar to 24S; however, the grains are more elongated in the former material. The presence of zinc in the 75S gives this material an age-hardening property which is not present in 24S material. Thus, an additional operation is required to place 75S in the "T" condition.

A solution heat-treatment and a cold water quench, similar to that used for 24ST, are followed by an artificial aging treatment. The solution heat-treatment temperature is slightly lower for 75S extrusions. After the cold water quench, both 24S and 75S will age harden at room temperature. But the improvement in properties takes place more slowly in 75S material. To obtain the properties of the "T" condition, a subsequent precipitation teatment is required.

Where and how to exploit fully the weight-saving possibilities of this new aluminum alloy are propounded in this article by Snyder and Crossland.

They describe the heat-treatment and aging necessary to develop the maximum physical properties in 75ST as well as its structural uses. The short column range is said to be the most advantageous application.

Judicious use of 75ST in redesigning the B-29 wing, the authors show, made it 16% stronger and 650 lb lighter.

After the cold water quench, 75S is in the "as quenched" condition which may be retained by storing at 0F. If "as quenched" material is allowed to age at room temperature, it increases in strength to attain properties known as the "W" condition and, in this condition, has greater strength than 24ST. The artificial aging operation may be accomplished by subjecting the material to a temperature of 212F for 4 hr, followed by a

* Paper "Use of 75ST in Structural Applications," was presented at the SAE National Aeronautic Meeting (Spring) on April 9, 1947.

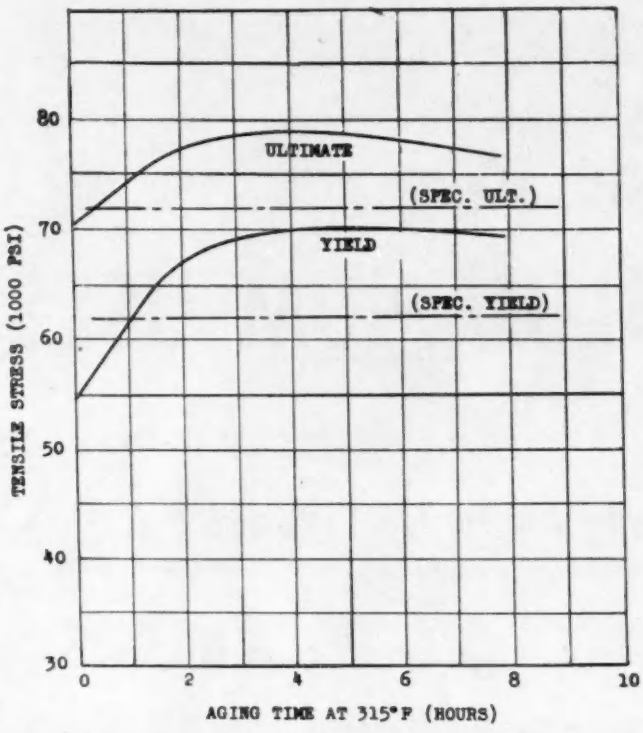


Fig. 1 – This illustrates the effect of aging 75S at 315F following solution heat-treatment and a 4-hr aging at 212F, as determined from limited test data

temperature of 315F for 8 hr. The effect of the 315F temperature is shown in Fig. 1.

Comparison of Structural Properties

A cursory comparison of the physical properties of 75S with 24S material would yield the conclusion that use of 75ST in place of 24ST represents a weight saving of 14% in tension sections and 35% in compression sections. If an equal distribution of tensile and compressive material is assumed, this indicates a total structural weight saving of 25%.

The structural engineer, however, will be quick to point out that this weight-saving estimate assumes the strength of a member to be directly proportional to its tensile and compressive properties – an assumption often erroneous for some typical aircraft structural members.

He may have in mind a particular section, perhaps a stiffener, which is now 24ST and is critical, under compressive load, in buckling of the web of the stiffener. Should this member be changed to 75ST and the web proportionately reduced to effect a weight saving, the stiffener will be critical in buckling at a lower compressive stress and the stiffener strength reduced.

Obviously the weight savings indicated by the preliminary inspection of 75ST properties may not be entirely attainable. However, in some instances, it may be possible to redesign the stiffener to increase the critical buckling stress without increasing stiffener area.

The preceding discussion of the stiffener applies to a complete airplane structure. It follows that indiscriminate substitution of 75ST for 24ST on the basis of ultimate and yield strengths to reduce gages and save weight may not increase overall structural strength. For the full utilization of 75ST properties, this material should be considered in the initial design stages.

The problem of stiffener instability is only one of many problems which must be faced by the structural engineer – whether he is substituting 75S in a current airplane or considering 75S for a new design.

Table 1 – Comparison of ANC-5 Design Properties for 75ST and 24ST

FORM	ALCLAD SHEET		EXTRUSION	
Material	75ST	24ST	75ST	24ST
Thickness (inches)	.040 to .500	.064 to .500	t < .250	t < .250
Specification	AN-A-10	AN-A-13	AN-A-11	QQ-A-354
Tension, ultimate (psi)	72,000 (T)	62,000 (T)	78,000 (L)	57,000 (L)
Tension yield (psi)	62,000 (T)	40,000 (T)	70,000 (L)	42,000 (L)
Compression yield (psi)	62,000 (L)	38,000 (L)	70,000	38,000
Ultimate shear (psi)	43,000	40,000	43,000	30,000
Ultimate bearing (psi)	108,000	95,000	101,000	85,000
Elongation (%)	8	13*	6	12

* 11% FOR t = .129 TO t = .500

(L) = Longitudinal – with grain
(T) = Transverse – cross grain
Bearing Properties are for e/d = 1.5

Compression Strength

One of the most important advantages of 75ST is its high column strength, a result of its high proportional limit and yield strength. Column curves for extruded 75ST, 14ST, and 24ST are shown in Fig. 2. The compressive yield stress upon which the curves are based is shown in the chart. The curves for 75ST and 14ST are based on tangent modulus data and are corrected to standard properties. The 24ST curve is the ANC-5 straight-line column curve.

The curves of Fig. 2 are valid for stable sections only. All local sections of the column, such as thin-walled webs and outstanding legs, must have a critical buckling stress greater than the allowable column stress.

If a local section is more critical than the column as a whole, the stable sections of the column become over loaded and the maximum column strength will be reduced. This is important, not only for initial design, but also when substituting 75ST for other alloys. The stability of local sections will, undoubtedly, be checked by the designer if he is determining the column strength of a new design. However, this factor must not be overlooked when substituting 75ST material.

The amount of weight saved or the increase in strength obtained using 75ST will be greatest for compression applications in the short column range, and less for tension and shear applications.

Fatigue life properties of 75ST are generally inferior to 24ST when comparing the fatigue strengths with the static strength of the base material.

Fatigue tests of riveted joints of 75ST alclad

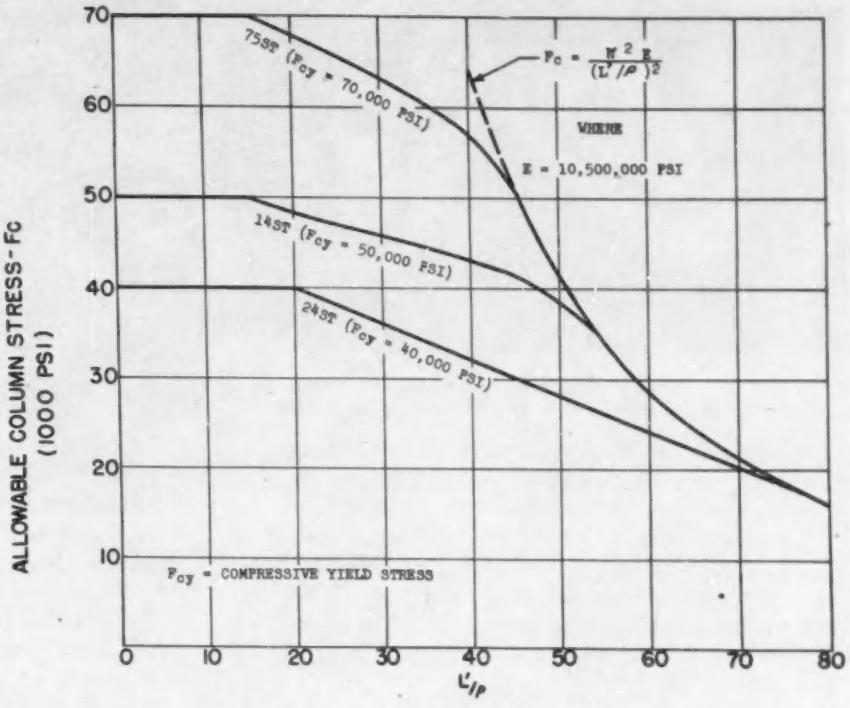


Fig. 2 – These allowable column curves for extrusions show the weight-saving ability of 75ST in the short column range

have shown less fatigue life than similar 24ST alclad joints when tested on the basis of the same percentage of the joint's ultimate strength. Test results for certain stress ranges of riveted joints have shown less fatigue life for 75ST alclad than for 24ST alclad tested under the same fatigue stresses.

Fuselage Application

The typical fuselage construction is a thin-skin shell supported by longitudinal stiffeners and circumferential rings. The strength of sections of the shell that are critical in compression are highly dependent upon elastic properties. That is, stiffeners are relatively long columns of light gage and the thin shell or skin panels have low critical buckling stresses.

In these cases the higher compressive properties of 75ST may be of little, if any, value. Some advantage may be gained by the use of 75ST for sections critical in shear. But because a thinner gage skin would be used, wrinkles will form earlier than when 24ST is used. If compression loads are combined with shear, the earlier wrinkling of the thinner 75ST alclad sheet may adversely affect the allowable combined load of the skin and stiffener combination.

Where panel rigidity requirements to prevent sheet vibration or inter-rivet buckling determine the minimum skin gage, the use of 75ST may be of no value. Skin and stiffeners of fuselage sec-

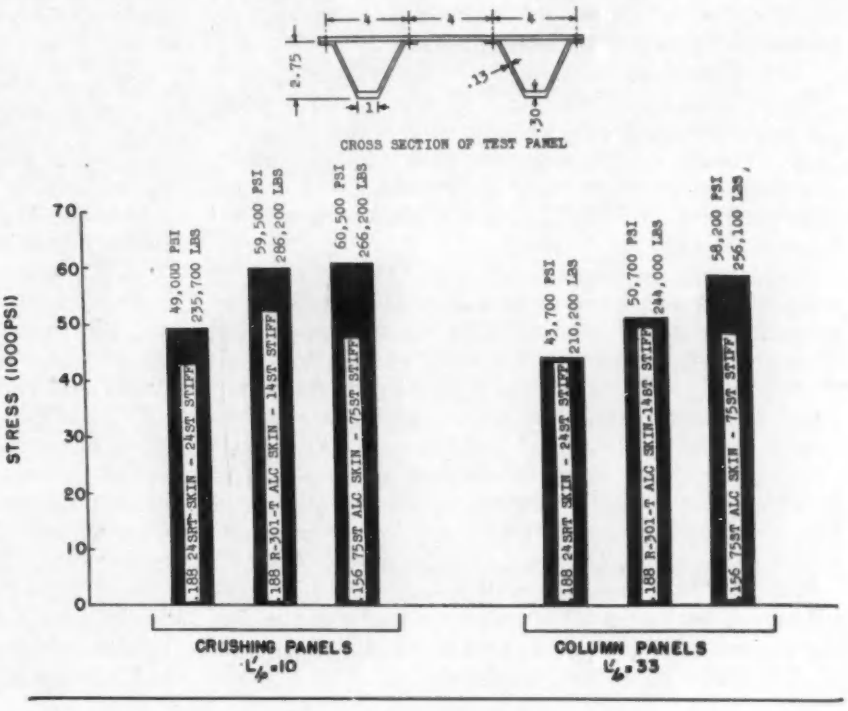


Fig. 3 – Testing B-29 upper wing compression panels showed that the 0.156-in. thick 75ST panel skin withstood a greater load than the 0.188-in. thick 24ST skin

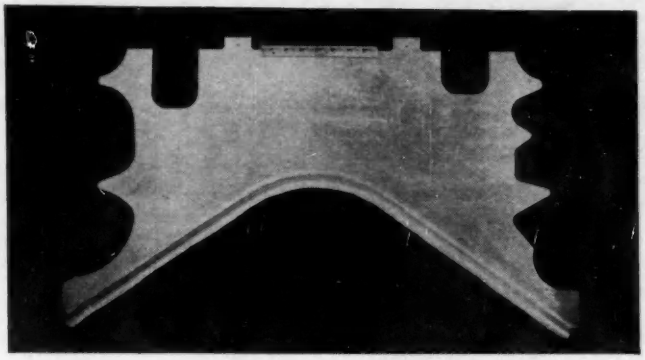


Fig. 4 – In the redesigned B-29 wing this lower skin reinforcement plate of 75ST replaced three parts of 24ST used in the original wing

tions critical in tension present none of these restrictions, except possibly the thickness requirement for prevention of sheet vibration.

Bulkheads which distribute high local loads to the fuselage – such as stabilizer and wing to fuselage attachment bulkheads – are of relatively heavy construction. The use of 75ST in bulkheads for web and frame members, therefore, will benefit the fuselage design.

Wing Construction

Typical wing construction is also a shell and usually consists of sheet-stiffener upper and lower surfaces separated by two or more shear beams or spars. Interior bulkheads or ribs provide rigidity to the shell. The spacing is such as to divide the upper surface into relatively short column lengths.

As shown in Fig. 2, 75ST can be used to advantage in the short column region if local instability problems can be overcome. The lower surface is stiffened because it is subjected to compressive stresses when negative bending loads are applied to the wing. But these stresses are usually only about 60% of those in the upper wing surface caused by positive bending loads.

Lower surface stiffeners are of relatively long column lengths where 75ST advantages are small for compression loads. However, for the high tension stresses in the lower surface due to positive bending loads, there may be considerable advantage in the use of 75ST; this possibility should not be overlooked.

Many wing interspar ribs and trailing edge or nose ribs are of light gage and critical because of elastic properties. These ribs do not require a high-strength material. The wing skin in the leading and trailing edge area is usually of minimum gage and determined by panel rigidity requirements so that the use of 75ST would present no advantages. But heavily loaded ribs – such as landing-gear support ribs, compression ribs, and flap or aileron support ribs – are constructed of stable components favorable to the use of 75ST.

Use of 75ST in spars will usually be advantageous. Even spars which show no advantage for the use of 75ST stiffeners and webs can make use of this material in the chords.

Heavy stable sections will be lighter if designed in 75ST, even when adjacent structure is of a lower strength material. Applications of this type are frames around doors and cutouts where loads are carried around openings, nacelle longerons for engine mount attachments, and chords for stabilizer and fin spars.

The B-29 wing has been redesigned in 75ST and is an excellent example of the use of 75ST in an aircraft structure. The redesigned wing was 16% stronger and 650 pounds lighter than the original wing. This gain was made in basic structure only, namely in the spars and the interspar surfaces. The interspar ribs and structure forward of the front spar and aft of the rear spar were not changed.

The upper surface of the inboard wing is constructed of heavy-gage skin stiffened with hat-section extrusions. A comparison of several test panels of the upper surface are shown in Fig. 3.

It should be noted that the 75ST panel skin is 0.156 in. thick and is alclad. Nevertheless it withstood more load than the 24S panel with 0.188 in. 24SRT (bare) skin.

As a result of these and other tests, all of the upper-surface interspar skin on the inboard wing was changed from 24SRT (bare) to 75ST alclad and reduced one gage in thickness. A slight reduction was also made in stiffener area, the web of the 75ST stiffener being changed from 0.13 to 0.11 in.

An interesting application of 75ST is shown in Fig. 4. This lower skin reinforcement plate, formed in 0.188-in. thick 75SO heat-treated to 75ST, replaces three parts used on the original wing. It was possible to use one piece for the redesigned wing because a mechanical operation, such as rolling, was not required to obtain maximum properties.

DESIGN AIMS FOR JET

continued from page 25

telltale in their latching. Even with these safeguards, it is desirable that the installation be capable of flight with any one latch of a particular piece of cowling unfastened.

Military standards allow only 45 min for changing an engine. This can be accomplished if engine and airframe manufacturers cooperate to design mounts and hoisting arrangements for quick removal and replacement.

5. *Control:* Control of the powerplant can be achieved with only a few controlling devices, but so far, little progress has been made in the development of really satisfactory devices. The trend with turboprop installations is to provide two levers, one for fuel and power and the other for rpm. Turbojet engines can be operated with a single lever for fuel and rpm.

Some aircraft have already been provided with controls for automatic sequence starting.

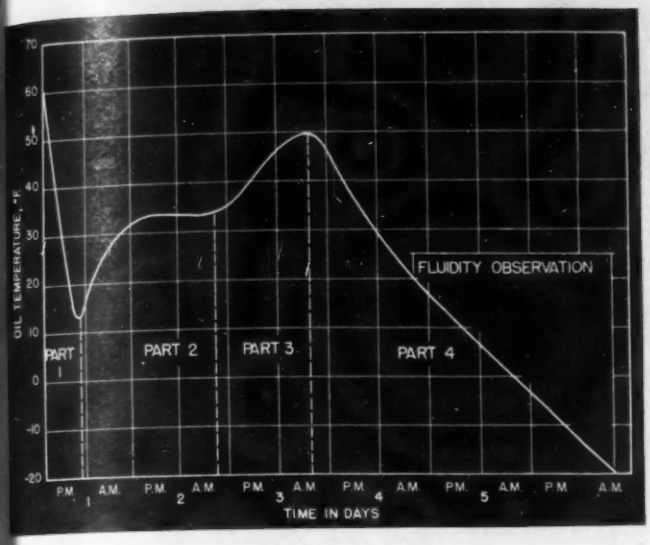


Fig. 1 – Instability of winter grade oils resulting in pour reversion is now studied under the above temperature cycling for six days in a laboratory cold box, replacing lengthy field tests

Study Winter Oil Pour Ability In Field-Duplicated Lab Tests

Digest of paper

By J. G. McNAB, D. T. ROGERS, and A. E. MICHAELS

Standard Oil Development Co.

and C. E. HODGES

Standard Oil Co. of N. J.

(This paper will be published in full in SAE Quarterly Transactions)

WINTER-LONG testing in the field of pour stability of winter grade oils containing pour depressants can now be replaced by equally effective six-day laboratory tests, the authors relate. They point out that:

Certain pour depressant-treated oils undergo pour reversion, or solidify, at relatively high temperatures during storage in cold climates. Pour reversion apparently stems from exposure to temperature cycles involving moderately low temperatures during which the pour depressant is alternately adsorbed on wax crystals and then desorbed.

Eventually the depressant fails to function effectively and the oil may solidify at temperatures considerably above its original ASTM pour point.

Difficulty in determining pour reversion tendencies has handicapped development of satisfactory winter grade oils using lightly dewaxed stocks. While actual winter storage tests establish stability characteristics, they require a whole winter to obtain information on any one oil. And since pour reversion varies from year to year, depending on the temperatures, arriving at a satisfactory answer may entail several years' work.

Extensive work by the Standard Oil Development Co., during which some 250,000 pour point observations were made on more than 2500 sample oils, evolved a six-day temperature cycle test in a laboratory cold box. This test includes the basic features of the temperature cycles causing severe pour reversion in the field.

Two different cycles are used – one for high cloud-point oils and the other for intermediate or low cloud-point oils.

The temperature pattern for high cloud-point oils, shown in Fig. 1, can be roughly divided into these four steps:

1. Rapid cooling from room temperature to about 15F;
2. Warming to 34F for 24 hr;
3. Warming to about 50F;
4. Cooling from 50F to – 20F over 72 hr at the rate of about 1F per hr.

Results obtained with this laboratory temperature cycling were in good agreement with winter field test solidification.

These tests will become more important as pour depressant additives improve and their use increases. These tests will differentiate between those oils that will remain fluid at all times stored in cold areas and those that solidify. (Paper "The Pour Point Stability Characteristics of Winter Grade Motor Oils," was presented at the SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 7, 1946.)

Naval Plans Dictate Future Diesel Fuels

Digest of paper

By CAPT. W. C. LATROBE

Bureau of Ships, U. S. Navy

THE Navy is up against the problem of urging industry to develop diesel fuels tailored to tomorrow's engines and hypothetical operations, declares Latrobe. Discussing future diesel fuels, he reports the Navy wants products that will:

1. Produce high specific outputs;
2. Operate in subzero weather;
3. Have no water-retention characteristics;
4. Be produced from nonpetroleum sources.

The Navy is spearheading its drive for higher output fuels with a two-flank attack. First, it is asking the petroleum industry to determine what additives will contribute to higher performance. Initial phase of this program provides for tests of the 90-cetane Fischer-Tropsch fuel from France, a 52-cetane fuel, a 50-50 blend of the Fischer-Tropsch and Navy fuels, a blend of 40% Fischer-Tropsch and 60% gas oil, and a 50-50 blend of gas oil and Navy fuel doped up to 50 cetane.

Second half of the program is the determination of those engine modifications that will take advantage of superior special fuels. Hope is held that this overall program will evolve a method for rating diesel fuel performance.

Since no one can predict where the next war will be fought, the Navy must be prepared to operate at temperatures from —50F to +125F. Future diesel fuels must be pumpable and have good starting characteristics in frigid zones.

Tests are now under way on such a fuel. It is primarily a mixture of branched-chain paraffins, has a pour point of —85F, and a cetane number of 58. Only apparent objections to it are the prohibitive manufacturing costs. But continued development should bring these production costs in line.

Because of their contact with sea water, Navy diesel fuels must not retain water in suspension. Water rapidly corrodes injectors. As little as 0.02% salt water in the fuel will do damage. While the water-retaining tendency of diesel fuels presently has no explanation, this bugaboo must be stopped.

On a par with water corrosion are the tendencies of certain fuels to foul or corrode atomizer tips or to deposit excessively in combustion chambers. In submarine warfare this can become a matter of life or death. The Navy wants the optimum in fuel cleanliness.

And in the same breath the Navy looks to successful development of

diesel fuels produced from coal, natural gas, and oil shale. High hopes already are held for these products in view of recent demonstrations with them. It remains for industry to provide the know-how to exploit fully these new fuels and provide our fleet with the extra margin of superiority it has enjoyed in the past. (Paper "Navy Diesel Fuel," presented at SAE Annual Meeting, Jan. 10, 1947.)

Boost Power Output By Engine Redesign

Digest of paper

By L. L. BOWER

Waukesha Motor Co.

EXPLOITING higher octane gasolines by refining existing engines produces the added power without resorting to costly development of new engine designs, Bower says. In one case he cites:

A 4-in. x 4¼-in., 6-cyl, 320-cu in. engine was redesigned to deliver greater power and increased speed by increasing the compression ratio and by providing a new camshaft for high-speed timing and improved carburetion. The compression ratio was increased from 5.95 to 6.2 to utilize 75 octane gasoline in place of 70 to 72 octane fuel. A cylinder head change made possible the higher compression ratio.

Betters Combustion

The new camshaft helps achieve a more complete change of incoming fuel-air mixture – particularly at higher speeds – by keeping the intake valve open for a longer period of time. The valve timing with this new camshaft takes advantage of the gas flow inertia effect so that the mixture enters the cylinder even after the piston starts on its up stroke. It's really a form of supercharging.

With the new camshaft timing, the intake valve remains open for 246 deg as against only 215 deg for the former design. The intake valve starts to open 8 deg before top dead center to permit starting the charge earlier at high speeds.

These improvements upped the bmep from 78 at 2800 rpm with the original engine to 86 at 3000 rpm on the refined model. (Paper "Redesigning for Improved Performance and Life of Modern Engines," presented at SAE Northwest Section, Feb. 2, 1947.)

Weighs '47 Prospects For Airline Profits

Digest of paper

By HAL E. NOURSE

United Airlines, Inc.

ECONOMIC checks and balances shape the airline business outlook in 1947, reports Nourse. He forecasts that:

Air transportation will show increases in all types of payload. While increased acceptance of air travel will gain women and children passengers, recent accident publicity will restrain 1947 passenger travel. Air traffic problems and terminal congestion may offset some of the advantages accruing from greater speed and more comfortable airplanes.

Among the profit-inducing factors will be increased mail volume due to the 5¢ airmail rate; technical improvements in airplanes and service; increased passenger fares, and a flattening of the overhead curve.

Nineteen forty-seven extends a challenge to airline management. Profits will not just happen; careful planning must make them happen. (Paper "Pertinent Economic Factors in Air Transportation – 1947," presented at SAE Annual Meeting, Detroit, on Jan. 10, 1947.)

Operating Factors Influence Efficiency of New Motor Oils

Digest of paper

By C. M. LARSON

Sinclair Refining Co.

FULL realization of the new Premium and Heavy-Duty motor oils' detergency and solvency characteristics depend on factors such as fuel type, engine design, and operating conditions, Larson shows. Outlining advantages and limitations of these lubricants, he reports that:

Both very lean air-fuel ratios and gasolines high in olefines promote lacquer formation on pistons.

With diesel fuels, end point and injection timing affect city bus operation. Cross-town buses in New York City idle 40 to 70% of the time. Such conditions lead to incomplete combustion and too-cool an engine so that oil control rings sludge.

While sulfur content in diesel fuels is limited to values as low as 0.25 and 0.50, Caterpillar engine tests with a 0.67 sulfur content fuel and Heavy-Duty oil (alkaline type) showed half the wear of an oil on the acid side. This basic Heavy-Duty oil and high-

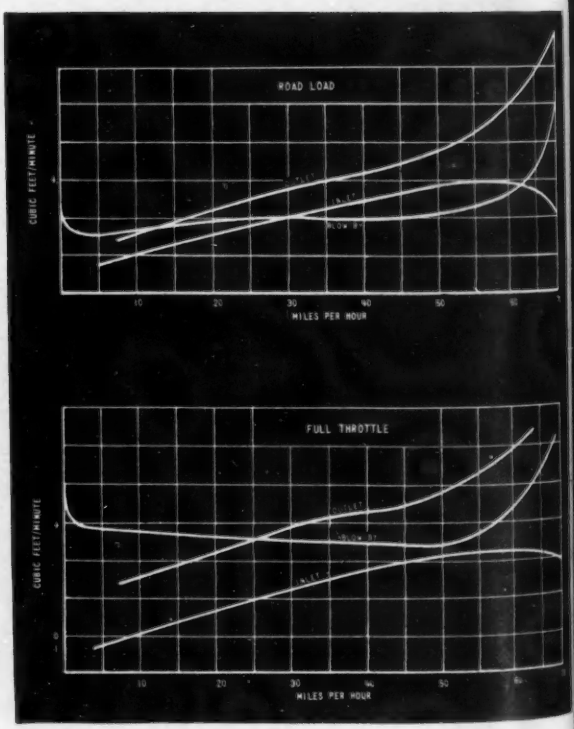


Fig. 1 – Blowby gases, contributors to engine sludge, were measured for a passenger car engine. The top chart shows that blowby was inadequately diluted with fresh air during acceleration or in speeds up to 30 mph. In the chart below for the same engine in a truck, blowby was dangerously high

gulfur fuel combination checked well within this engine's wear limits.

Effect of blowby gases on engine sludge relates directly to adequacy of crankcase ventilation. With a new type of flowmeter developed at Ford, data in Fig. 1 for a passenger car engine was obtained. It shows that the crankcase ventilation system does not sufficiently dilute blowby gases with fresh air in either acceleration or speeds up to 30 mph.

Blowby due to ring fluttering assumes gigantic proportions at speeds over 60 mph.

The lower curve illustrates the increase in blowby using the same engine in a heavily loaded truck in road service. Hot blowby gases exceed the amount of inlet air dilution through the breather through the entire range of operation.

Tests have proved that engine deposit causes can be eliminated at the source with adequate ventilation and scavenging of combustion products from blowby and oil oxidation vapors. In certain cases, reverse-mounted bus engines with inadequate crankcase ventilation failed at only 14,000 miles due to excessive oil screen deposits despite use of Heavy-Duty oil.

Truck engines performing poorly with additive-type oils have cleaned up after installation of the pressure ventilation system in Fig. 2. Pressure ventilation has been especially effective in vehicles for door-to-door service. The mayonnaise-like cold engine sludge in winter operation – a combination of moisture, blowby and soot – has been cleared with pressure ventilation when conventional systems proved inadequate.

Taxicab engines operating with minimum positive ventilation in the excessive blowby speed range have shown excessive crankcase deposits. Indicative of the deadly character of blowby products of combustion and crankcase fumes are the high lead and ash content coupled with high acidity in an analysis of taxi cab scavenger outlet material.

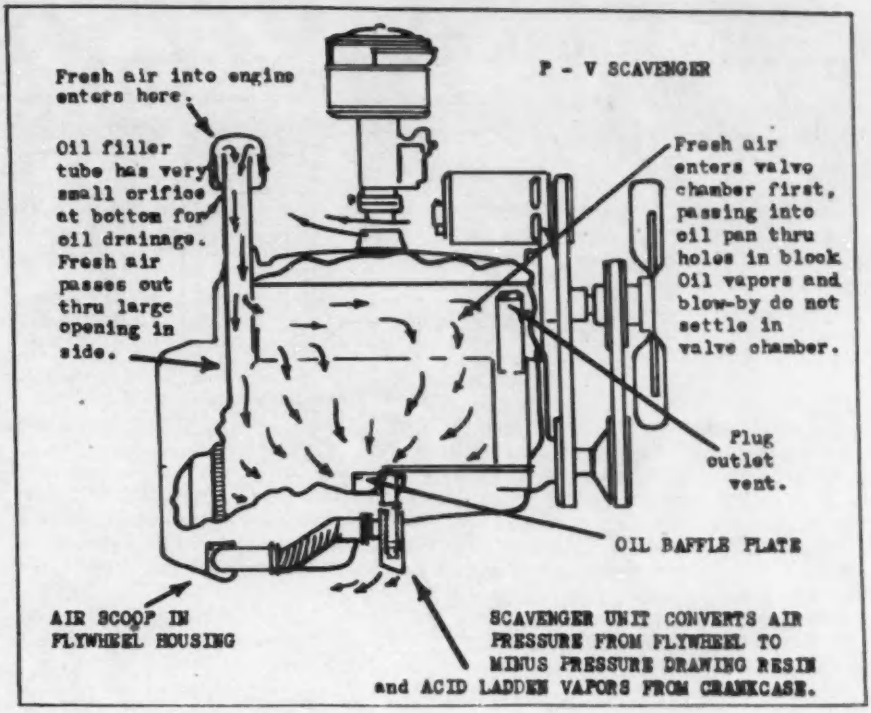

Fresh air into engine enters here.
P - V SCAVENGER
Oil filler tube has very small orifice at bottom for oil drainage. Fresh air passes out thru large opening in side.
Fresh air enters valve chamber first, passing into oil pan thru holes in block. Oil vapors and blow-by do not settle in valve chamber.
Plug outlet vent.
OIL BAFFLE PLATE
AIR SCOOP IN FLYWHEEL HOUSING
SCAVENGER UNIT CONVERTS AIR PRESSURE FROM FLYWHEEL TO MINUS PRESSURE DRAWING RESIN and ACID LADDEN VAPORS FROM CRANKCASE.

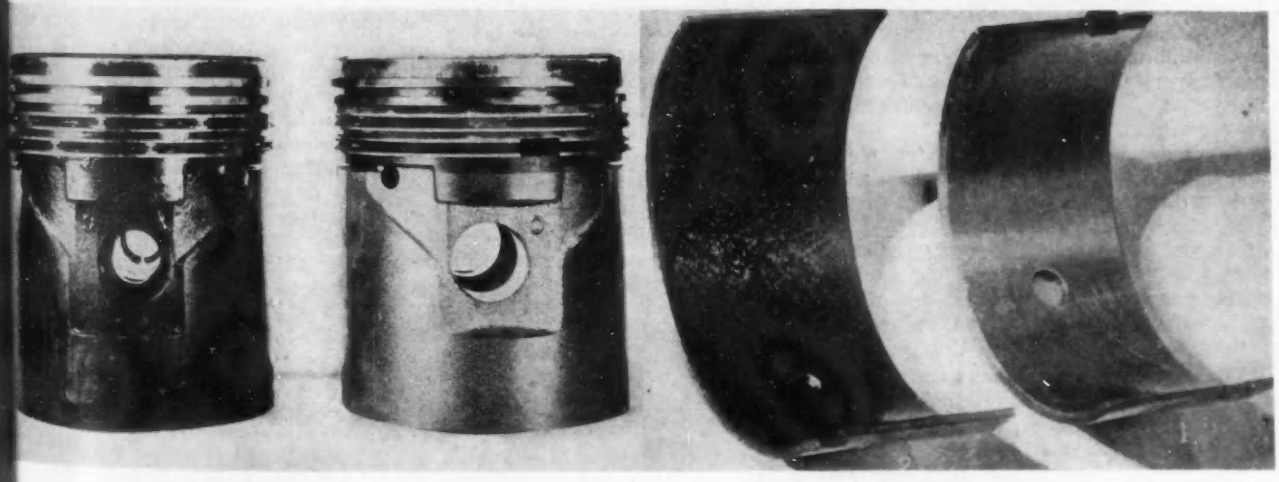
Fig. 2 – This pressure-ventilation scavenger system employs the flywheel blower effect to discharge blowby gases and oxidation vapors of crankcase oil

Varnish deposit substance, composed of these materials, closes holes in intake of crankcase breathers and coats oil screens. Carried in the crankcase, this material also increases piston lacquer despite the use of Premium or Heavy-Duty Type oils.

Poor maintenance and engine age multiply blowby fumes several times and add to deposit and lacquer formations.

Many passenger car and truck operators have benefited using Premium Type oils regardless of poor ventilation and maintenance, and improper loading and fuels. Fig. 3 illustrates improvements piston and bearing ratings made after switching to Premium oil. (Paper "The New Motor Oils – Their Benefits – Their Limitations," presented at SAE St. Louis Section, Feb 11, 1947.)

Fig. 3 – These before-and-after photographs demonstrate deposit reduction obtained after changing to Premium Type motor oil in passenger car and more severe light truck service



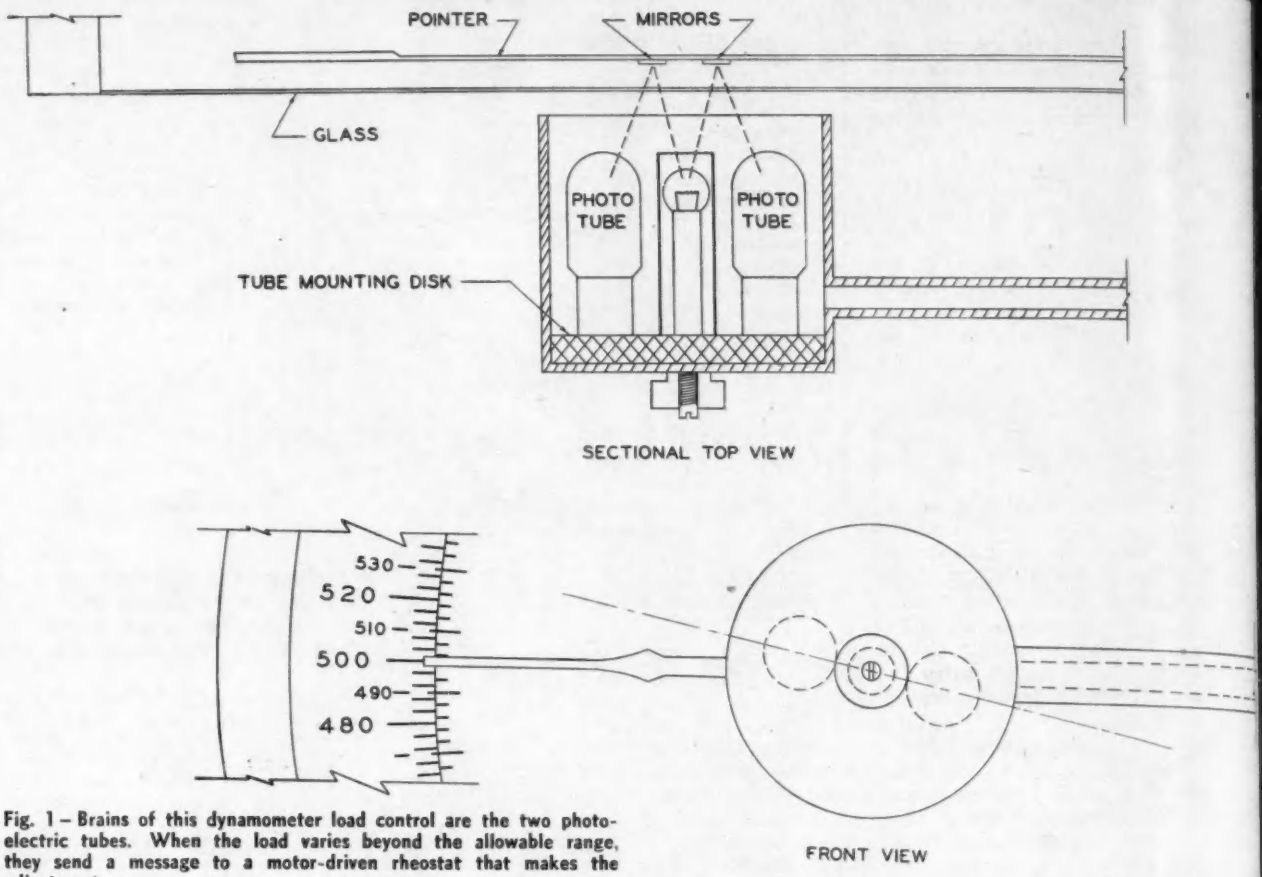


Fig. 1 – Brains of this dynamometer load control are the two photoelectric tubes. When the load varies beyond the allowable range, they send a message to a motor-driven rheostat that makes the adjustment

Tells Simple Rules For Governor Design

Digest of paper

By G. B. GRIM

Caterpillar Tractor Co.

APPLYING common-sense do's and don't's in engine governor design yields optimum results, Grim advises. For example:

Keep friction between working parts to a minimum. Damping to arrest dynamic inertia forces will always result from that friction you can never design out of a part.

Parts design should be both simple and light in weight, with care given to weight distribution. In one case, a fuel pump housing was altered to provide reciprocating bearings for the slide bar; but the designer found the rack and bar too heavy to be arrested at the end of their travel. Result: they overran by far their correct setting.

While the first remedy appeared to be redesign with the original plain bushings, the quicker travel possible with ball bearings still appeared too attractive to abandon. The answer was reduction of the mass of reciprocating parts.

Avoid sliding members. They contribute heavily to total friction. Keep the mechanism simple; the number of parts is proportional to the number of links. Joints add friction. Parts add inertia.

Provide adequate lubrication. Force-feed lubrication is seldom needed. A splash system is satisfactory and easily incorporated into the design.

Don't expect the governor to anticipate load changes. It recognizes only speed changes and only then corrects the fuel delivery rate. After fuel rate adjustment for a change in load, only the engine can correct the speed. The engine must pick up the load with fuel provided by the governor.

Nor can it correct roughness or inherent irregularities of engine power delivery. In fact the governor may compound some irregularity by trying to correct it, being always too late with its correction. (Paper "Governing of Internal Combustion Engines," presented at SAE Peoria Section, Jan. 3, 1947.)

Electronics Control Dynamometer Loading

Digest of paper

By M. R. CLAPP

The Lubrizol Corp

PHOTOELECTRIC tubes have been incorporated into a simple automatic control that maintains uniform dynamometer loads without requiring constant adjustment of fluctuations, Clapp reports. Describing the device, he points out that:

It consists of a pair of photo tubes that follow load variations and make corrections through a motor-driven rheostat in the dynamometer field.

The photoelectric element of the control unit is mounted in front of the dynamometer scale dial. A pedestal extending from the scale frame supports an arm that is adjustable about a center coinciding with the scale pointer axis. A cylindrical cup at the end of this movable arm contains the two photo tubes and a light source.

The ¾-in. diameter tubes and the 3-cp 6-v lamp make up a compact 2-in. diameter assembly. The lamp is mounted on a disc between the two tubes.

This disc rotates within the cup by means of a screw on the outside.

As shown in Fig. 1, two small mirrors cemented to the scale pointer reflect the light beam from lamp to photo tubes when the pointer interrupts the beam. Since rotating the tube mounting varies the angle between the tubes' line of centers and the pointer, the period of coincident exposure of the two tubes may be adjusted. This adjustment sets the control point width and control sensitivity.

Fig. 2 depicts control action with respect to the tubes' light beam position. The period of lower tube illumination alone is the control point. When the beam falls below the lower tube, the load is increased by the motorized field rheostat until the control point is reached. The reverse occurs when the load increases to where the beam falls above the upper tube.

A pilot lamp on the control panel flashes when the load is above or below the control point. Since the control motor has a speed of 1 rpm and a maximum travel of one revolution, the lamp remaining lit for more than 1 min notifies the operator that the load change is outside the control range and requires manual correction.

The control has a range of 20% of the applied load and sensitivity may be adjusted from ½% to 2%. The control unit is built of conventional elements. Only modification to the dynamometer scale was the cementing of the mirrors to the pointer. (Paper "A Photoelectric Dynamometer Load Control," presented at SAE Annual Meeting, Jan. 9, 1947.)

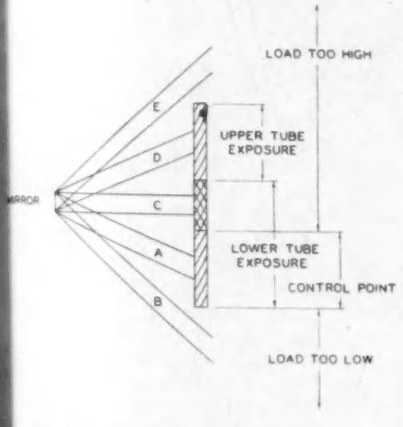

LOAD TOO HIGH
E
D
UPPER TUBE EXPOSURE
C
A
LOWER TUBE EXPOSURE
CONTROL POINT
B
LOAD TOO LOW
A - BEAM ON LOWER TUBE ONLY - CONTROL POINT
B - BEAM BELOW LOWER TUBE - LOAD TOO LOW
C - BEAM ON BOTH TUBES
D - BEAM ON UPPER TUBE ONLY — LOAD TOO HIGH
E - BEAM ABOVE UPPER TUBE

Fig. 2 – It's done with mirrors. If the scale pointer moves too far and breaks the beam from lamp-to-mirror-to-lower tube, the rheostat goes to work and brings the load back in line

Dirt Root of Lubrication Evils Oil Man Warns Fleet Operators

Excerpts from paper

By JOSEPH M. SILLS

Socony-Vacuum Oil Co., Inc.

WHAT is the most important thing in properly lubricating a fleet? The answer to me isn't engine oil, grease, or gear oil. It is the way these products are used and abused. And I think the worst abuse is dirt. I can't think of any more elaborate term.

The oil man appreciates the importance of dirt. He has learned to keep his manufacturing operations almost surgically clean because he knows what an enemy dirt is to his products.

What if you – the fleet operator – opened a brand new drum of grease and right on top you found a nice handful of dirt? You couldn't jump fast enough to phone your supplier to give him the devil. And you would make him take the stuff back. You might even get mad enough to change suppliers.

Careless Habits

But on the other hand, you think nothing of opening that same fresh barrel of product and leave the lid off – or the bung open – and let accumulate that same handful of dirt before it is consumed. You think nothing of dipping a dirty hand into the barrel in order to "hand pack" a bearing. (I should call it "hand wreck" a bearing.)

You may have very carefully washed that bearing in solvent. You might even have it clean when it comes out of the cleaning bath before you start to handle it with dirty hands. Then you might even set it down on a dirty bench while you go over and dip a dirty hand into the grease supply.

Somehow or other you manage to put some dirt into the bearing before you put it back in service. It may be in packing the hub, where the dirt may be knocked from the brake, or the wheel as it goes back on. It can be, and is, added in a hundred different ways. Then when the bearing fails, you call in the oilman and say, "Look what your blankety blank grease did to my poor bearing."

Clean overalls, clean hands, and clean faces too, all are important from an oil man's viewpoint. I have walked into a good many garages since the war. Without even saying good morning to the man in charge, I know that there are two strikes on our products before they even begin to do their job of lubricating the vehicle.

Stop and consider the job that a ball or roller bearing is called upon to do. Contact between ball and race is theoretically a point contact; in the case of the roller bearing it is a line contact. A point is defined as a location without area. Pressures at this theoretical point can and often do reach 500,000 psi.

Practically speaking, of course, it no longer is a point without area when this load comes on. This has been very clearly proven by one of the big bearing manufacturers, who statically loaded a bearing and then blew a sulphide gas over it. When the race and ball were inspected it was found that the area of contact was eliptical. The ball and race are elastic and change shape under pressure, much the same as a tennis ball would do if you pressed on it with your hand when in contact with a table.

This flexing can only take place so many times before fatigue failure takes place. This phenomenon will take place regardless of the lubricant used in the bearing. It can easily be demonstrated by flexing a common paper clip. Its intended use includes only slight flexing; under these circumstances it will last a long time. However, bend it to 90 deg. a few times and see how rapidly it fails through fatigue.

The ball bearing too will last quite a while – as it is designed to do – if it only has to flex under designed load conditions.

Dirt Hurts

Now comes the black hand gang. Let's put one or two microscopic pieces of dirt on the race. What happens? The flexing is increased each time the piece of dirt passes under a ball. It's like a stone in your shoe – it hurts! A stone in your shoe, if left there, will wear a hole in your foot as dirt in a bearing will wear a hole in the race or the ball – or both. The experts then look at the wreckage and solemnly declare, "Metal fatigue." Some might even call it lack of lubrication.

Now I don't want to imply here that dirt only gets into roller bearings.

Consider the transmission and the differential. In some shops I have seen recently it would be almost impossible to add lubricant to either of these parts without also adding dirt. It goes in when the filler plug is removed. It goes in when the dirty finger goes in to test the level. It goes in almost without fail when the filling nozzle is applied.

Consider what the gears inside this

box have to put up with. They are asked to operate at ambient temperatures of from —50 to +200F. The gear teeth must operate at temperatures up to welding heat. Pressures on the teeth may range from 75,000 to 450,000 psi. And rubbing speeds may be as high as 1,800 fpm.

Now let's throw in a little dirt. After the gears fail, the experts look at them and say, "Too bad – scored, scratched, fatigued." What they really mean is that the poor gears were irritated to the point of failure by what you did when you threw in that dirt.

Other Sore Spots

Nor do we need to confine this to bearings and gears. Let's look at the engine for a moment. We need hardly look into the measuring can or at the pouring spout to find the dirt you have been adding with the oil. Or if you use a pressure dispenser, what about the dirt that is added again with your dispensing nozzle? It is almost impossible to find any such equipment that is surgically clean.

And we haven't yet talked about the dirt around the filler cap, the dip stick, or the man that is handling the oil. All we need is a little abrasive material in the oil – no matter how it gets in – to accomplish the abuse I have been discussing.

Think for a moment about the engine. It employs rotating bearings as well as sliding action on the cylinder walls. And the products of combustion further complicate the problem.

Adding Heat and Pressure

Ambient temperatures at which it operates range from —50 to +200F. The oil may reach temperatures as high as 300F, and the bearings will almost always be 30 to 50° hotter than the oil. Cylinder walls may go to from 400 to 450F, and the piston head is even hotter.

Gas pressures go as high as 1200 psi, rod and main bearing pressures may be as high as 3500 psi, and piston pins are even higher. Pistons move at speeds up to 60 mph, and bearings move at over 30 mph.

Now carelessly throw a little dirt into this maze of moving parts. What chance has the oil got? Not a chance when it comes to overcoming the effect of dirt.

And don't forget the chassis. It is equally important to the operation of the vehicle. Even the spring shackle is important. Every time the dirty grease gun is applied to a dirty fitting, a measured amount of dirt is forced in – to help wear out the pin and bushing. The universal joints receive the same charge of dirt along with the grease if the fitting and grease gun are not cleaned. King pins, tie rods, and innumerable other places can be as badly abused by careless treatment.

All the oil man can do is go away cussing after seeing all the abuses that are commonly practiced in the shop, when it comes to handling and dispensing petroleum products.

I have made this sound as if no vehicle would go out and run even for a single day without failing from all this dirt you add.

I don't want to leave that impression because we know it is not true. Between the vehicle manufacturer and the oil man, the equipment of today has a very fine chance of out-living its before-the-war predecessor, despite increases in bearing pressures, compression pressure, overall road speed, and payload. (Paper "Fleet Lubrication," presented at SAE Pittsburgh Section, Jan. 28, 1947.)

Truckmakers Strive To Cut Service Needs

Digest of paper

By D. B. ERMINGER

International Harvester Co.

BUYERS begrudge the immediate dollar, don't worry much about the future one. For this reason, Erminger points out, manufacturers are faced with the difficult problem of producing vehicles that will perform well under average conditions with standard lubricants and requiring only normal servicing – at a low initial cost. Pioneering is more apt to lose customers than to gain success. The manufacturer must attack the problem of lessening service requirements without much cooperation from his customers.

There are ways, he says, in which servicing can be reduced on present trucks:

1. Better buying: special units are designed around standard models for special jobs. The operator can have an almost custom-made vehicle by choosing the right basic model and optional units.

2. Better driving: good driving practices plus daily care and inspection can reduce maintenance.

3. Better operation: manufacturer's information about vehicle capacity and proper methods of operation and maintenance subtracts from servicing requirements.

4. Better servicing: manufacturers make constant efforts to improve service facilities of their dealers, and to make helpful recommendations for operator services. Parts and complete replacement units are economically supplied.

5. Better roads: manufacturers know the value of good, safe roads, take active parts in highway safety campaigns.

Meanwhile, manufacturers constantly investigate relevant fields of metallurgy, design, engineering, and chemistry, and cooperate with raw materials producers in the effort to improve vehicles. Laboratory tests, proving ground tests, and rigid inspections of materials and manufacturing tolerances are supplemented by field tests and consumer surveys.

Service Demands Met

Every truck part, he says, has felt improvements on the manufacturing level. Each year manufacturers come nearer to their goal of providing trucks that will be accepted by the public and that will deliver the greatest number of miles of operation with the least possible servicing. (Paper "The Elimination of Causes of Frequent Servicing – A Manufacturer's Viewpoint," was presented at SAE National Transportation Meeting, Chicago, April 16, 1947.)

Spots Recent Strides In Gasoline Refining

Digest of paper

By DR. C. D. LOWRY, JR.

Universal Oil Products Co.

PRESENT-DAY motor fuel production volume and quality relegate petroleum technology of only 25 years ago to the dark ages of refining, declares Lowry. Tracing the accelerated progress in petroleum chemistry, he demonstrates that:

World production of crude oil in 1945 totalled 7,000,000 bbl per day as against only 1,900,000 bbl per day in 1920. Gasoline yield based on crude was about 27% some 25 years ago; 41% in 1945; and could equal 75% with modern equipment.

During the first World War we sent abroad a maximum of 37,000 bbl per day of gasoline; in World War II we produced a half million bbl per day of aviation gasoline alone.

First important processing advance – thermal cracking and reforming – now produces half of our gasoline and is responsible for both an increase in fuel quality and enormous conservation of crude oil. Introduction of catalysts within the last ten years sparked the use of alkylation, isomerization, and catalytic cracking.

Alkylation – synthesis of iso-octane and its isomers – was harnessed during the last war to produce 135,000 bbl of alkylate for aviation gasoline. Most

dramatic use of catalysts was made in catalytic cracking. One hundred catalytic cracking units produced base stock for aviation fuels during the war. Together with the alkylation plants, they made possible the great improvement in motor gasoline since the war.

To counteract both gum-forming tendencies when stored and foul smell of cracked gasolines, technologists found that anti-oxidants and inhibitors effectively and economically stabilize the product.

These and other technical contributions benefiting both the nation and the general public justify the slogan "Petroleum Is Progessive." (Paper "What the Chemist and Chemical Engineer Have Done to Motor Fuel in the Last Twenty Five Years," presented at SAE Kansas City Section, Nov. 18, 1946.)

Develop Instrument to Study Auto Knock

Fig. 1 – Knockometer and oscilloscope in car

Digest of paper

By J. H. GOFFE
and J. W. WHEELER

Sperry Gyroscope Co., Inc.

(This paper will be published in full in SAE Quarterly Transactions)

AN instrument for studying knock in automotive vehicles, the KM-4 knockometer, has been developed by adapting the aviation detonation instruments described by Costa and Wheeler.[1]

With its auxiliary equipment, it can perform the following tasks:

- Detect and measure knock level, rating fuel similar to the ear of a skilled operator.
- Detect which cylinders are knocking.
- Record the knock level against traces from which the speed can be measured.
- Assist in the analysis of abnormal engine vibration conditions due to valves or other sources.

The KM-4 is convenient to use and installation (excluding the auxiliary tachometer drive adaptor) takes only an hour (15 min if cables have already been installed). It can be used with any of the present-day test methods – Borderline, Modified Uniontown, and Standard Uniontown – and on road, chassis dynamometer, and engine dynamometer installations.

Approximately the same cabinet size as the KM-1 knockometer used in aircraft work, it includes voltage regulation and automatic volume control. For short tests it can be placed on the seat of an automobile, as shown in Fig. 1. (Paper, "Development of Detonation Instrumentation for Automotive Vehicles," was presented at the SAE Annual Meeting, Detroit, Jan. 9, 1947.)

[1] See *SAE Journal*, Vol. 55, April, 1947, pp. 27-29, 37: "Rating Fuels with Knockometer," by P. J. Costa and J. W. Wheeler.

New Transmission Suited to Logging

Digest of paper

By PAUL E. FORSYTHE
and ROBERT S. LANGDON

Western Gear Works

THE new combination hydraulic-mechanical Torq-Master transmission speeds logging operations by converting engine power to higher speed or torque as demanded by the load, Forsythe and Langdon reveal. Reason:

Adding a mechanical transmission to a hydraulic torque converter provides top efficiency throughout the 6 to 1 torque multiplication range. This is a must in logging because of the steep grades and ground obstructions.

Output shaft of the torque converter is geared to two step gears in a rotating cylinder. Locking cylinder rotation with an air-operated brake drives the output shaft at a reduced speed of 2 1/3 to 1. Releasing the brake and clutching the cylinder housing to the converter output shaft gives direct or high drive.

The Torq-Master provides instantaneous lower gear ratio with momentary heavy load pull, permitting engine and converter to continue operation in their efficient speed range.

Other successful applications are being found for this transmission. Used with a 120,000-lb track loader, it provides flexibility in both the propelling and hoist drives. The Torq-Master installation with a diesel-driven veneer lathe produces satisfactory results. (Paper "The Pacific-Western Torq-Master Transmission – A Recent Development in the Logging Field," presented at SAE Northwest Section, Nov. 1, 1946.)

Knowing Your Oil Betters Lubrication

Digest of paper

By IVAN E. HOWARD

Phillips Petroleum Co.

MOST vehicle operators are guilty of two motor oil sins, says Howard. They buy words, not lubrication; then they misuse the products they buy. He argues that:

Individually, terms like viscosity index, flash point, paraffinic base, and carbon residue have little bearing on lubricant quality. Only when used collectively to determine a lubricant's characteristics do these specifications have any significance.

Correct diagnosis of lubrication needs calls for a knowledge of lubricating oil refining processes because oil behavior is traceable to these three factors:

1. Its molecular structure;
2. Process and care with which it is refined;
3. Conditions under which the product is used.

For best results, buy the motor oil that fits your type of service. Follow manufacturers' recommendations. It's far better to use an oil one SAE number too heavy than one too light.

Drain your oil often. Part of its job is to clean the engine. But if you leave it there too long, dirt in suspension will

stick to hot spots. Then you are in trouble. The average user spends less than $20 per year for oil. But how far will $20 go today for overhauling an engine? (Paper "Lubrication Problems in the Field," presented at SAE Peoria Section, Jan. 3, 1947.)

Comfort Needs Grow As Air Travel Spreads

Digest of paper

By ALBERT P. ELEBASH

Pan American Airways, Inc.

LOWER air rates will draw a broader cross section of the traveling public. Aircraft of tomorrow will carry more of the aged, ill, very young, and other special groups than ever before.

This means, Elebash explains, that minimum standards of comfort will rise. What was a luxury yesterday will be a necessity tomorrow.

The very minimum needs are going to be

1. Safe, reliable, on-time transportation;
2. Comfortable seats;
3. A place to stow personal things;
4. Cabin air conditioning;
5. Toilets;
6. Smoothness;
7. Minimum noise and vibration; and
8. Good lighting.

These minimum requirements expand as the trip lengthens from short haul to transcontinental or transocean and overnight. Anything over 3 hr should be considered a long-haul flight, and includes as necessities:

1. Ample rest rooms and washing facilities;
2. Extremely comfortable reclining seats with foot room;
3. Some choice of accommodations;
4. Diversion or facilities for it;
5. Good food with a choice of menus and ability to meet special diet needs.
6. Individual tables.

Planning of interiors must take the economic factor into account; planes cannot be designed for either long or short-haul service to the exclusion of the other without waste. A money-saving flexible interior will include reversible seats and seats that can be stowed away. Seat fittings might be installed 20 in. apart, to allow 40-in. spacing on short hauls, 60-in. on long hauls.

Prime problem of the airlines now, Elebash points out, is to speed up service – particularly in terminals and on the ground. Only when airlines' biggest advantage of speed is realized in this way will "plush" interiors keep customers. (Paper "Passenger Aircraft Facilities – Design and Operation," was presented at SAE National Air Transport Engineering Meeting, Chicago, Dec. 3, 1946.)

Water Injection Slows Combustion

Digest of paper

By EDWARD F. OBERT

Northwestern University

CERTAIN theories about combustion in an engine are useful, no matter what mechanism is proposed for the processes of combustion and detonation. Prof. Obert explains:

Under conditions of detonation, it appears that burning and expansion in one part of the gas compresses another part to its spontaneous ignition temperature. The explosive reaction – detonation – which results may occur in the unburned portion ahead of the flame front. Or, in the regions where combustion has already occurred, there may be an explosive release of chemical energy not expended in the flame front. Either way, detonation is characterized by an abnormally high rate of release of energy, which causes a definite pressure difference to exist within the combustion chamber.

Retards Autoignition

Water suppresses detonation by reducing combustion pressure and by lowering temperature in the end zone. Dilution of the charge with water slows flame-front travel. Before maximum pressure is reached, the piston has receded farther on its expansion stroke. Compression is less, and the autoignition temperature is less likely to be reached.

Vapor Cooling Beneficial

Of course, the reductions in flame-front travel and pressure could be achieved by retarding the spark. However, tests show that to attain a given degree of detonation suppression by spark retardation, combustion pressure must be lower than is necessary with water injection. Apparently, water performs some function other than that of slowing combustion. It is concluded that the cooling effect of the vaporization of water in the end zone is a factor preventing detonation. Tests demonstrate that water must be finely atomized and given plenty of time to vaporize if it is to be fully effective.

Water injection to reduce detonation is marked by an increase in exhaust gas temperature and a decrease in coolant load, it has been shown in experiments. Water injection seems to curtail heat transfer during the combustion and expansion processes. (Paper "Detonation and Internal Coolants," was presented at SAE National Aeronautic Meeting, April 10, 1947.)

Logging Saw Engines Give Constant Torque

Digest of paper

By F. DAVISON

Industrial Engineering Co., Ltd.

TORQUE characteristics of the two-cycle, crankcase-compression gasoline engine meet needs of power chain saws for logging operations, says Davison, because:

The engine has a flat torque curve. This is highly desirable since the operator loads the engine by pushing the blade into the tree. Other load variations arise from factors such as knots in the wood and pinching of the bar or chain.

These sudden load increases almost instantly lower the engine's speed.

An engine with a good flat torque curve continues to exert about the same amount of drag on the chain. It will continue pulling the chain through the cut since the reduced chain speed through the cut reduces the force required to pull it. An engine whose torque falls off with a speed drop would probably stall before the operator could ease the load on it.

The crankcase-compression two-cycle engine suffers from inherently poor fuel consumption because of exhaust port losses during scavenging and heavy dilution of the lubricating oil. But with the small horsepowers in chain saw work (where 8 hp is ample for the largest machine), this is of little importance.

However, it does preclude use of this type of engine for many other uses requiring higher powers.

With the advent of cheap superchargers for scavenging and timed fuel injection, these difficulties can be overcome. It may be that cars in the near future will be powered by two-cycle engines.

The power saw engine's simplicity, lightness, and ruggedness add to its adaptability as a power source in tree cutting. Oil added to the gasoline in the fuel tank lubricates and cools the working parts. (Paper "The High-Speed Two-Cycle Engine in Power Chain Saws," presented at SAE British Columbia Group, Vancouver, Nov. 6, 1946.)

TECHNICAL COMMITTEE PROGRESS

Revamp Shaft Standard For Marine Propellers

Widespread use of SAE propeller shaft coupling and wheel hub standards by interested manufacturers and the military services sparked the recent organization of an SAE committee to bring these standards up-to-date.

A survey indicated that the SAE Standard on Motorboat Propeller Shaft Ends and Hubs (adopted in 1929 and revised in 1935) and the SAE Recommended Practice on Motor Boat Propeller Shaft Couplings (formulated in 1929) are basically adhered to by marine designers as well as the Army, Navy, and Coast Guard.

In fact, the Navy advised these standards rendered yeoman service during the war. Over 90% of the small boats and landing craft procured by the Navy during the war were fitted with propellers and shafts conforming to SAE Standards. According to the Bureau of Ships, these standards greatly facilitated Naval procurement and design standardization.

The Coast Guard, when asked whether the standards should be dropped, strongly urged their retention, labeling them confusion-eliminators and great time-savers in checking designs.

While they rate high in marine design, it is felt that these standards – for shaft diameters from ¾ to 8 in. – need modernization in keeping with current practices. Among the items needing such study are shaft taper and keyway dimensions.

The new Committee, composed of leading marine engineers from industry and the services, agreed to retain the ¾-in. per ft taper on smaller shaft sizes and to specify a 1-in. per ft taper for shafts 6 in. in diameter and larger.

Fault found with present keyway dimensions is with excessive depth and sharp corners. Fatigue cracks start readily in sharp keyway corners, wartime experience revealed.

To alleviate this condition, the conferees intend

SAE TECHNICAL BOARD

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	L. C. Zeder

to reduce keyway depth and to provide a standard maximum fillet for shafts larger than 2 in.

The SAE Committee on Marine Propeller Shaft Ends, Couplings, and Hubs

G. L. McCAIN

Chairman of the SAE Committee on Marine Propeller Shaft Ends, Couplings, and Hubs

has assigned two subcommittees – one on shafts and hubs and the other on couplings – to review in detail the old standards and to recommend any revisions or additions.

Serving on the Committee with Chairman G. L. McCain, Chrysler Corp., are D. T. Abbott, Columbian Bronze Corp.; J. F. Bachman, Ford Motor Co.; N. J. Brazell, Bureau of Ships, U. S. Navy; W. F. Burchfield, International Nickel Co.; P. G. Tomalin, Naval Engineering Division, U. S. Coast Guard; L. S. LeGros, Scripps Motor Co.; D. E. McCready, Michigan Wheel Co.; and J. W. Westphall, Sterling Engine Co.

Jet Alloy AMS Near Completion

FIFTEEN SAE Aeronautical Materials Specifications for high-density heat-resistant alloys used in jet engines are speeding toward completion.

According to A. W. F. Green, Allison Division, GMC, chairman of the AMS Subdivision group developing these first-of-their-kind specifications, revised drafts he prepared are being circulated among Committee members and suppliers. Two groups meeting during the second and third week of this month, on the West and East Coasts respectively, will review comments and recommendations received. After modifying the specifications accordingly, the Committee will process them through the usual Aeronautic Committee and Technical Board channels for final approval.

The jet engine materials specifications under way are as follows:

● AMS 5360 – Steel Corrosion and Heat-Resistant Precision Investment Castings (17 Cr-13 Ni-2 Mo)

Application: Small parts used at temperatures up to 1600F, such as stator vanes, nozzles, and diaphragm vanes. While strength of this steel at high temperatures is slightly higher than that of 18-8 types, oxidation resistance is similar.

● AMS 5365 – Steel Corrosion and Heat-Resistant Sand Castings (25 Cr-20 Ni)

Application: Welded parts and assemblies requiring oxidation resistance up to 2000F. It's also useful at higher temperatures when stresses are extremely low.

● AMS 5366 – Steel Corrosion and Heat-Resistant Precision Investment Castings (25 Cr-20 Ni)

Application: Small parts – such as stator and nozzle diaphragm vanes – used at temperatures up to 2000F. Strength of this steel at high temperatures is similar to that of 18-8 types and its oxidation resistance is superior.

● AMS 5375 – Alloy Corrosion and Heat-Resistant Precision Investment Castings (Cobalt Base 25 Cr-5 W)

Application: Primarily for small parts – particularly turbine blades or buckets – requiring high strength up to 1500F and oxidation resistance up to 2000F.

● AMS 5378 – Alloy Corrosion and Heat-Resistant Precision Investment Castings (Cobalt Base 32.5 Ni-25 Cr-5.5 Mo)

Application: Primarily for small parts requiring high strength up to 1500F and oxidation resistance up to 2000F. This alloy is the most machinable of all alloys in the same group and is suitable for turbine blades.

● AMS 5380 – Alloy Corrosion and Heat-Resistant Precision Investment Castings (Cobalt Base 27 Cr-15 Ni-6.3 Mo)

Application: Same as AMS 5375.

● AMS 5385 – Alloy Corrosion and Heat-Resistant Precision Investment Castings (Cobalt Base 27 Cr-25 Ni-5.5 Mo)

Application: Same as AMS 5375.

● AMS 5512 – Steel Sheet and Strip, Corrosion and Heat-Resistant (18 Cr-10 Ni-Cb)

Application: Parts and assemblies requiring both corrosion and heat resistance, especially welded parts. It provides oxidation resistance up to about 1500F, but is useful at that temperature only when stresses are low.

● AMS 5521 – Steel Sheet, Corrosion and Heat-Resistant, Deep Drawing and Spinning Quality (25 Cr-20 Ni)

Application: Parts and assemblies requiring oxidation resistance up to about 2000F, but may be used at higher temperatures when stresses are extremely low.

● AMS 5522 – Steel Sheet, Corrosion and Heat-Resistant (25 Cr-20 Ni-2 Si)

Application: Same as AMS 5521, except that the specified silicon content improves oxidation resistance with some sacrifice in both weldability and ductility.

● AMS 5542 – Alloy Sheet, Corrosion and Heat-Resistant (Nickel Base 15 Cr-2.5 Ti-1.0 Cb-0.7 Al)

Application: Parts requiring high strength up to 1500F and oxidation resistance up to 2000F. Processing and heat treatments affect available properties at various elevated temperatures. Particularly is this useful for parts such as turbine wheels or discs, buckets or blades, and nozzle diaphragm blades.

● AMS 5560B – Steel Tubing, Seamless, Corrosion-Resistant (18 Cr-9 Ni)

Application: Parts and assemblies – such as fluid lines – subjected to high pressure that require corrosion resistance and are not welded in fabrication.

● AMS 5646 – Steel, Corrosion and Heat-Resistant (18 Cr-10 Ni-Cb)

Application: Same as AMS 5512.

● AMS 5652 – Steel, Corrosion and Heat-Resistant (25 Cr-20 Ni-2 Si)

Application: Same as AMS 5622.

● AMS 5667 – Alloy, Corrosion and Heat Resistant (Nickel Base 73 Ni-15 Cr-2.5 Ti-0.95 Cb-0.7 Al)

Application: Same as AMS 5542.

The following changes in the commodity committee structure were announced by AMS Subdivision Chairman J. B. Johnson, Air Materiel Command:

1. The Corrosion-Resistant Alloy Committee is now combined with the Heat-Resistant High-Density Alloy Committee under the chairmanship of A. W. F. Green. He will be assisted in expediting West Coast consideration of these specifications by Vice-Chairman R. E. Pelzel, Douglas Aircraft Co.

2. A single Aluminum and Magnesium Alloy Products Committee will replace both the aluminum and magnesium wrought products groups and will be chairmanned by L. D. Bonham, Lockheed Aircraft Corp., with G. T. Williams, Pratt & Whitney Aircraft, as vice-chairman.

3. Williams also will replace R. J. Metzler as chairman of the Copper Alloy Products Committee.

4. The new Plastics and Synthetic Rubber Committee, under Chairman R. R. Janssen, North American Aviation, Inc., combines two former groups.

5. Changing both its name and scope, the Plating and Protective Coats Committee becomes the Finishes and Processes Committee, with W. C. Schulte, Curtiss-Wright Corp., continuing as chairman.

See Plane Tire Wear Curbed by New Device

LONGER-LIFE airplane tires are being visualized by SAE Committee A-5, Aircraft Wheels, Brakes, and Axles, if its hopes for an antiskid mechanism materialize. Other projects progressing under this group's guidance aim at

increased safety through greater brake reliability.

Use of a standardized antiskid device offers real rubber-saving possibilities in landing of air transports. At present, it doesn't take too many feet of skidding to ruin an airplane tire. And what complicates the problem is the fact that the pilot usually doesn't know when the tires are skidding.

Development of some device that absorbs the skid-producing energy would make sizable savings in airline tire-replacement costs.

While the Committee feels it is not in the gadget-inventing business, it has agreed to outline some design and performance requirements of such a device. Preliminary discussions at the last meeting revealed that a direct torque control will not work; variations in landing surface materials and weather conditions (such as snow and rain) would change the torque required.

It appears that more effective antiskidding might be achieved by a design based on the relationship between a guide wheel (such as the nose wheel) rpm and the braking wheel rpm.

When is a brake effective and how can you tell – moot questions to date – should be answered by a standard field test for brakes being completed by the Committee. Importance of the human element in brake operation complicates the task. How well a brake functions has been a matter of pilot discretion.

The test procedure being evolved will evaluate a brake through measurable performance characteristics. It will outline a taxi pattern for the test and define minimum requirements for items such as brake cooling time, temperature, fade, pedal travel and pressure, and lining wear.

A third important item on Committee A-5's agenda is a proposed revision to Specification AN-B-2, Design of Brake Systems. It includes a new conception of the term "W" – used in determining required brake energy capacity. The revision designates "W" as the design gross weight or take-off weight as opposed to airplane landing weight – the nomenclature in the original specification. The conferees accepted this change.

But the Committee did take exception to the kinetic energy factor of 0.042 (for preliminary design of a tricycle gear airplane) as called for in AN-B-2. According to C. W. Davies, Air Materiel Command, actual procurement requirements of military equipment can be based on a 0.032 factor without providing excessive capacity. The group went on a record as preferring the 0.032 value since it is consistent and ample, except for proposed design weight considerations.

Chairman W. H. DuBois, Bendix Aviation Corp., announced the appointment of H. H. Kerr, U. S. Rubber Co., as a member of the Committee.

New Standards Focus On Spark-Plug Nut

ADDITIONS to the spark-plug section in the 1947 SAE Handbook includes two recently approved standards for (1) a snap terminal for ignition wire cable ends and (2) a revised spark-plug terminal nut.

The snap terminal standard, illustrated in Fig. 1, covers only the slotted-jaw construction of the terminal blade. The SAE Electrical Equipment Committee, which developed this standard, points out that it intentionally avoided standardization of the ferrule or the means of attaching the terminal to the cable because of wide variations in current constructions.

Some are crimped on, some soldered on, and some crimped and soldered. Others consist of a special ferrule, hollow-riveted to the terminal blade itself. Still others are a one-piece stamping which forms both the terminal blade and the cable attaching cup. This type of terminal is used with or without a fiber insulating sleeve over the ferrule.

The second new spark-plug standard is a revised plug terminal nut which includes a groove in its base, shown in Fig. 2, into which the thrust-type terminal can be snapped. Addition of the groove will give a proper fit for the thrust-type blade. Width of the terminal's narrow dimension on the old nut is unsatisfactory for this purpose.

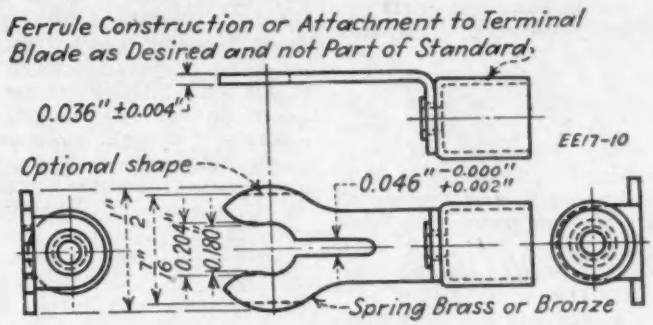


Fig. 1 – This standard terminal blade for ignition wire cable ends will appear for the first time in the 1947 SAE Handbook

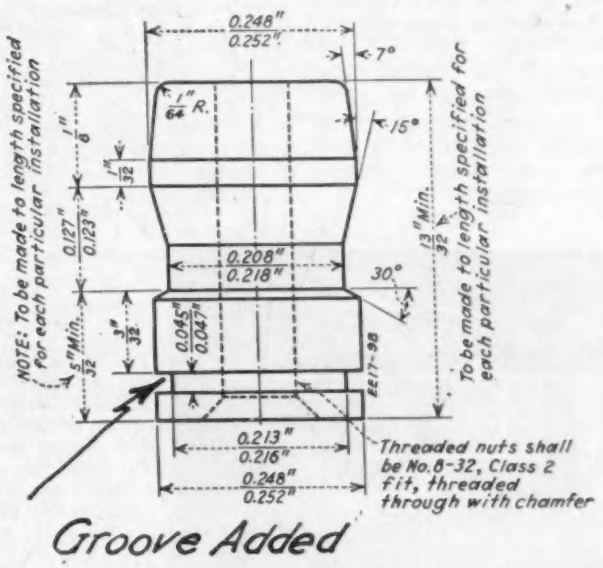


Fig. 2 – Terminal nuts on SAE Standard spark plugs – automotive type – have been revised to include the groove shown. This will provide a better fit for the new standard terminal blade in Fig. 1

Probe for Reliable Hydraulic Ring Seal

SEARCH for a dependable hydraulic packing back-up ring occupies top billing in the extensive program being tackled by the SAE Aircraft Hydraulic and Pneumatic Equipment Committee.

Sealing internal leakage of hydraulic fluid between the piston and cylinder wall is the key to successful operation of hydraulic equipment. Effectiveness of the back-up ring and O-ring seal combination, shown in Fig. 1, governs efficiency of the system; excessive leakage renders the system inoperative.

SAE Committee A-6 is investigating both back-up ring constructions and materials to find a combination that gives long service life and holds up under extreme operating pressures and temperatures.

Chairman B. R. Teree, The Weatherhead Co., reported progress in development of a 1500-psi 4-port relief valve

One possibility, reported F. O. Hosterman, Lockheed Aircraft Corp., is a leather ring backed up by a thin metal ring plus a removable piston head. Severe tests, simulating the worst possible service conditions, showed this configuration to give improved performance in addition to revealing several other facts.

Pressed leather rings seem to last longer than unpressed leather types – especially those thicker than 1/16 in. It is also desirable to place the grain or "hair" side of the back-up ring next to the O-ring seal, according to test results.

Investigation of an impregnated leather ring was suggested by J. N. Smith, E. F. Houghton Co. He found a thermal-setting resin to be a successful impregnating agent, whereas wax was unsatisfactory.

envelope. Based on returns from an industry-wide survey, the valve envelope will be similar to that of the present 3000-psi valve covered by SAE Aeronautical Recommended Practice 342.

An AAF proposed specification outlining required performance of an entire pneumatic system for air-pressure operated controls was considered acceptable by a majority of airplane and equipment manufacturers, according to a committee-conducted survey.

Summarized by J. M. Kidd, Glenn L. Martin Co., these comments will be forwarded to the Aircraft Industries Association for transmittal to the Army Air Forces.

Two other specifications – for a pneumatic relief valve and pneumatic reducing valve – have received majority industry approval and will be sent to AIA for submittal to the Aeronautical Board Working Committee. The relief valve proposal is to provide the WCAB with information for preparation of an AN specification.

Finding a suitable nonflammable hydraulic fluid still occupies a high priority on the Committee's agenda.

F. O. Hosterman, appointed by the AIA Aircraft Research and Testing Committee to coordinate that group's work with SAE Committee A-6, emphasized that their initial efforts are being directed to development of an interim "fluid." The fluid is intended for use with commercial airplanes with existing packings.

Although such material is not yet available, Hosterman felt this objective may be realized in the near future. Results of the AIA Committee's efforts will be transmitted to Committee A-6 as a tentative specification in the near future.

A report also was given on the Navy's success with a fluid known as Hydrolube "U" in nine Corsairs over a 13-month period.

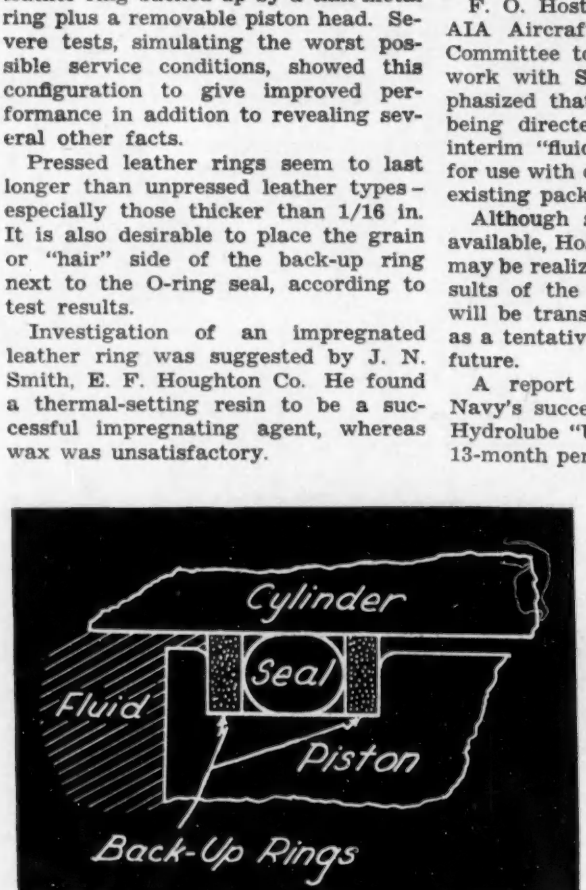


Fig. 1 – To prevent hazardous and costly leakage of hydraulic fluid past this seal in aircraft systems, the SAE Aircraft Hydraulic and Pneumatic Equipment Committee is on the hunt for a longer-lasting back-up ring design and material

Evolving New Series Of Washer Standards

FOUR new series of plain washers for all general industrial uses are being whipped into shape as an American standard by both the SAE Parts and Fittings Committee and ASA Sectional Committee B27, Plain and Lock Washers, despite many difficulties in the past.

The four proposed washer series – light, medium, heavy, and extra-heavy – are an extension and rationalization of the present SAE Standard on Plain Washers.

Most past differences between washer makers and users have been reconciled. But complaints from coin-box operators – that unscrupulous use of certain SAE Standard washer sizes as slugs makes a sizable dent in profits – remain a problem.

Slugs Vex Phone Company

While most coin mechanisms have been modified to reject all coin-like washer sizes, this petty larceny still persists in telephone coin collectors. The 7/16-size washer – with an OD of 15/16 in. (0.938) – physically matches the minimum size quarters in circulation – with a 0.939-in. OD.

Present telephone coin collectors reject slugs on the basis of outside diameter and thickness. While more discriminating rejection devices can and are being used in special cases, their more sensitive and complex functioning invites frequent service disruptions, the phone companies claim.

The telephone group requests reduction of the 7/16-washer OD to 59/64 in. (0.922) to provide their rejection mechanism with a working margin well below the coin size range.

The decision of both committees to effect the requested change depends on its feasibility from an engineering usage standpoint rather than on factors such as tooling changes, stock availability, or practice. The $64 question here is whether a reduction of the 7/16 washer OD from 15/16 to 59/64 in. would affect its performance with a tolerance of ± 0.010 applying to either dimension.

Final answer awaits returns from an industry survey.

Taussig Appointed

WARREN TAUSSIG, vice-president of Burlington Truck Lines, Inc., Galesburg, Ill., has been appointed vice-chairman of the SAE Transportation & Maintenance Activity Committee by Vice-President Don K. Wilson.

Taussig succeeds the late Robert H. Clarke in the post.

Issue New SAE Specs for Truck Fuel Tanks

Fig. 1 – These test results served as the basis for the recently issued SAE Recommended Practice on Side-Mounted Gasoline Tanks. The 18-gage, soldered lock-seam tank at left was dropped from 30 ft; its seams split, side separated from baffle, and the corner was crushed. The 12-gage all-welded tank, in the center photo, suffered a total damage of only a crushed corner after a 30-ft drop. At right is shown a fire resulting from release of the lower fusible plug with the tank in an inverted position.

ADOPTION of an SAE Recommended Practice for side-mounted gas tanks on truck tractors providing for a tank highly resistant to both rupture from impact in an accident and to explosion marks completion of a project initiated at the request of the Interstate Commerce Commission.

These performance specifications – developed by a subcommittee of the SAE Motorcoach and Motor Truck Committee – are aimed at minimizing injuries, deaths, and property damage from severe fires caused by exploding and sideswiped tanks. A letter of appreciation to the Society acknowledging receipt of the report from W. Y. Blanning, Director, Bureau of Motor Carriers of the ICC, says that "adoption of this specification will result in a greater degree of safety on the highway."

Chairman of the Motorcoach and Motor Truck Committee, W. P. Michell, Spicer Mfg. Co., reports another potential byproduct use of this report. The Underwriters' Laboratories – one of whose engineers was invited to sit with the Committee – is understood to be developing a side-mounted gasoline tank specification which, if and when it is issued, will be consistent with the SAE Recommended Practice.

In the test procedure outlined by the Committee, consideration is given to two important properties of any side-mounted gas tanks – ability both to resist impacts and to withstand explosion when subjected to external heat or fire.

Testing Tank Strength

Rather than limit design by setting up stress analysis criteria, the Committee established drop tests as an index to impact-resisting ability. The Recommended Practice specifies that the test be conducted as follows:

Fill the tank with water equivalent in weight to its gasoline capacity. Drop the tank from a free height of 30 ft so that it strikes squarely on one corner against a concrete surface. To pass the test, the tank must not rupture nor leak; the fill-pipe and cap, gasoline gage sending device, air intake, and safety vents shall not leak more than 1 oz per min after impact.

To test the fill-pipe, the tank filled with water (as above) must withstand a 10-ft drop striking squarely on the fill-pipe without rupturing or leaking.

The 30-ft drop is said to be the equivalent of the impact in sideswiping a bridge abutment. The tank's terminal velocity in the 30-ft drop is approximately 30 mph.

Fire Test Conditions

Explosion-proof properties of the tank are considered satisfactory if its safety vents limit the internal pressure build-up to 50 psi when exposed to fire under these two conditions:

1. Tank filled to 75% rated capacity with standard gasoline and inverted, with gasoline feed outlet plugged;

2. Tank enveloped by flame sufficiently intense to raise internal gasoline temperature 6 to 8 F per min, starting from a gasoline temperature of 50 to 80 F.

Another anti-explosion requirement is that the tank and all its appurtenances withstand, without rupture, an internal hydrostatic pressure of 150%, the maximum pressure at which the safety vent releases in the fire test.

Test work upon which these recommendations are based was conducted by the Committee at the Mack Mfg. Co.'s facilities at Allentown, Pa. Fig. 1 shows the results of some of these tests.

Constructionwise the report imposes no limitations on materials or production processes. It does suggest that joints be welded, brazed, or silver soldered. It also specifies that drain or tank-bottom fittings permit complete drainage and that they be installed to prevent their being torn loose.

The fitting through which gasoline is fed or drawn must have its exit from the top of the tank, says the report. Among other features specified is the incorporation of a nonspill type air intake vent. It may be mounted separately or combined with the filler cap or safety vent.

Feed Line Design

Maximum liquid capacity of the tank should be limited to 95% of its volume.

Installation recommendations cover location of fill-pipe, method of mounting, and arrangement of feed lines. For example, the report says the feed line shall not draw gasoline from two or more tanks simultaneously. Where more than one tank is used, a selector control valve must be furnished. The valve may be installed to permit operation by the driver while driving. Another permissible alternative is a valve requiring the driver to leave his seat to operate it.

Although this project was initiated in 1939, ICC delays and interruption during the war stymied real progress until early in 1945.

Plan New Work

The Committee will not disband now that the side-mounted tank project is completed. It will develop similar recommendations for chassis gasoline tanks and diesel fuel tanks, with E. P. Gohn, Atlantic Refining Co., taking over leadership of the group.

Serving with Gohn on the Fuel Tank Subcommittee are C. J. Bock, GMC Truck & Coach Division; J. H. Dunn, Aluminum Co. of America; and F. B. Lautzenhiser, International Harvester Co.

About

FREDERICK C. CRAWFORD, president of Thompson Products, Inc. (left), received the Cleveland Technical Society Council's first Distinguished Service Award from Prof. G. Brooks Earnest, Case School of Applied Science and Council President (right), and Clarence L. Collens, Chairman of the Board of the Reliance Electric & Engineering Co. The award was made to Crawford because of his outstanding contributions to the "advancement and welfare of engineering and the technical professions."

EUGENE L. MENCH has been appointed to the engineering staff of Nash Motors, it was announced recently by **FLOYD KISHLINE,** Nash chief engineer. Mench will be in charge of truck engineering. He has been connected with the International Harvester Co. and the Army Ordnance Department.

Industrial and governmental demand for research in electronics has resulted in an expansion of the electronics laboratories of Battelle Institute, Columbus, Ohio, Director **CLYDE WILLIAMS** has announced.

The old and the new in transportation was the subject of an address April 30 by **HAROLD T. YOUNGREN,** Ford vice-president and director of engineering, before 400 members of the Engineering Society of Detroit. His talk highlighted a program that included a tour through the Edison Museum, an inspection trip around the Ford test track and a visit to the Ford wind tunnel.

GEORGE STERN recently accepted the position of sales engineer with the Ferro-co Corp. in Brooklyn, N. Y. Previously he had been production and purchasing manager for the Atlas Steel Products Co., New York City. Stern's new duties entail the negotiating of contracts and the procurement of products and materials.

JOHN D. AMOROSO has left the Sterling Engine Co. in Buffalo to join the American Sigma Corp. as an engineer. His new company manufactures precision die castings.

C. A. WITHINGTON, JR., who had been owner of his own business, is now affiliated with the United Motors Service, Division of General Motors in San Francisco, serving as zone service manager.

No longer associated with International Business Machines, Endicott, N. Y., **HAROLD M. BURDICK** is now employed at the Food Machinery Corp. of San Jose as a designer.

L. S. MARTZ has joined the Marvin Hahn Advertising agency in Detroit as account executive. Prior to this he was assistant to the president of Micromatic Hone Corp., also Detroit.

Previously a student at the University of Colorado, **WILLIAM A. BLAKEY** is now an associate engineer with the Phillips Petroleum Co., Natural Gasoline Department, Bartlesville, Okla.

ROBERT D. BEATTY, JR., has gone into business for himself in Shaker Heights, Ohio. He had been chief engineer of the Research Department, Eaton Mfg. Co., Cleveland, Ohio.

Preceding his appointment as chief engineer of the Diesel Division, Fulton Iron Works Co., St. Louis, **LESLIE D. CALHOUN** was assistant chief engineer in charge of new design and development, General Machinery Corp., Hamilton, Ohio.

Until recently superintendent of automotive equipment with the Los Angeles Transit Lines, **W. L. CRAVEN** has now become operating manager of the Key System Transit Lines in Oakland, Calif.

J. MUSSER MILLER has been advanced to head of the Automotive Division, Sales Technical Service Department at the Standard Oil Co. in Chicago. Heretofore he was division engineer with this company in Detroit.

Having served as test engineer, American Liquid Gas Corp., Pasadena, Calif., **WILLIAM A. RUBLY** is now sales engineer for the Continental Motor Sales & Service Co. in Los Angeles.

WATSON BOYER, who had been carburetor engineer with Lycoming Division, AVCO Corp., is now an experimental engineer with the Ford Motor Co., Dearborn, Mich.

WHITE EXPANDS IN NEW YORK

P. E. "JERRY" TOBIN (left), regional manager of the White Motor Co. in the New York City region, has announced the opening of a new branch in New York City to take care of increasing service demands in that area. **G. TAYLOR MYERS** (right), formerly New York City sales manager, will be in charge of the new National Accounts Division and will be located in the new branch. One of his assistants will be **HARRY BURKHARD.** Tobin has been a member of the Metropolitan Section Governing Board for the past two years.

Members

FREDERICK G. HUGHES has retired as vice-president of General Motors Corp. and general manager of its New Departure Division at Bristol, Conn. He plans to devote more time to outside interests and to community endeavors in which he has always had a great interest. Hughes has been a member of the SAE since 1910.

FRANK T. WARD, vice-president and chief engineer of the Third Avenue Transit Corp., New York City, has been elected chairman of the Mechanical Standards Committee of the American Standards Association. He will represent the American Transit Association. **D. E. BATESOLE,** chief engineer of the Norma-Hoffmann Bearing Corp. in Stamford, Conn., is one of four new members of the Executive Committee of the MSC and will represent the SAE.

Recently becoming associated with the Fabor Laboratories, Los Angeles, as field service engineer, **JOHN G. CRAWFORD** had been with the Shell Oil Co. in Long Beach, Calif.

Now an engineer with the National Tube Co. in Lorain, Ohio, **ROBERT S. JOHNSON** was a field engineer, American Cyanamid Co., Plastics Division, Wallingford, Conn.

Having left the United Automotive Service in Harrisburg, Pa., where he was a sales and service engineer, **CHARLES ROSS MEYERS, JR.,** has taken a similar position with the Motor Ignition Co. in Philadelphia.

Having been discharged from the U. S. Army Corps of Engineers, where he held the rank of lieutenant colonel, **MUNSON ELLIOTT** recently became a sales engineer, Industrial & Diesel Engine Sales, at the Highway Equipment Co., Cincinnati.

THOMAS PETER DALLOW, recently an aerodynamicist with the General Electric Co. in Schenectady, N. Y., is a project engineer in the Flight Test Division at the U. S. Naval Air Test Center in Patuxent River, Md.

Now with the propeller Division of Curtiss-Wright Corp., Caldwell, N. J., **MAURICE THOMAS ROSE, JR.,** had been a student at Cornell University.

JOHN EDWARD KNOBLOCK has left the National Advisory Committee for Aeronautics, Cleveland, where he was a research engineer, to become assistant to the chief of engine design, Ford Motor Co., Dearborn.

Recently graduated from Texas A & M, **JACK W. BROWN** is now employed by the Ashby Drilling Co. in Dallas, Tex., as a drilling engineer.

JOHN H. MATTHEWS has been elected vice-president in charge of the Manhattan Rubber Division of Raybestos-Manhattan, Inc., Passaic, N. J. He started as a machine shop draftsman with Manhattan in 1914 after graduating from Stevens Institute of Technology. In 1940 he became assistant factory manager and in 1942 became assistant general manager of the Manhattan Division.

O. H. CILLEY, assistant general manager of the United States Asbestos Division of Raybestos-Manhattan, Inc., Manheim, Pa., was recently made a vice-president. In 1920 he became associated with the United States Asbestos Co. (now the United States Asbestos Division) as plant superintendent and in 1928 became assistant general manager. Cilley has been a member of the board of directors since 1941.

ROBERT W. BUDD has resigned from the Central Greyhound Lines, Inc. to take over the presidency of Great Lakes Greyhound Lines, Inc., Detroit. He started his bus career in 1926 with the Northland Transportation Co. of Minneapolis as mechanic, and by 1930 was president of the company. He is a director of the National Association of Motor Bus Operators.

THEODORE R. DINSMORE has been made special assignment engineer at the Frigidaire Division of General Motors Corp., Dayton, Ohio. He will be assigned to production on home freezers, ice cream cabinets and washing machines. Prior to this post he was chief engineer with the Scientiae Corp. in Dayton.

JAMES J. PERKINS, JR. has joined the sales staff of the Walter S. Peper Co., Long Island City, N. Y. They are sales representatives of the Davisbilt Products Co. Perkins served in the Army Air Forces and with Intava, Inc., gaining much experience in automotive engineering, particularly with ground equipment for aircraft refueling and servicing.

SAE Fathers and Sons . . . . .

HARRY A. TORGIS (left) is vice-president of A. L. Torgis & Son, Ltd., Toronto, and has been an SAE member since 1944. His son **LAWRENCE H.** is assistant manager of the company's engine rebuilding plant, a position to which he was appointed on his discharge from the armed service.

A member of the SAE since 1933, **J. G. MOXEY** is pictured with his son **JOHN G. MOXEY, JR.** Moxey, Sr. is a transportation engineer in Philadelphia. His son is assistant chief engineer of the Automotive Section at Sun Oil Co., Marcus Hook, Pa. He joined the Society in 1937 and is chairman of the Philadelphia Section.

If any SAE reader knows of any SAE Father-and-Son combinations both of whom are members of the Society, your editors would appreciate hearing from you. Several SAE members have two Member-Sons.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated – we don't want to miss any SAE Father and Son grouping.

J. ARTHUR SCOTT (left) and his son **HUGH F.**, who is general plant manager at the Precision Engineering Co. in Los Angeles. The elder Scott, who has been an SAE member since 1944, is an inspector with the Consolidated Steel Corp., also in Los Angeles.

EDWARD R. DEVINE is now a body builder in maintenance at United Truck Lines, Inc., Spokane, Wash. His duties will entail the maintenance of all trucks and trailers. Heretofore he was connected with the Quitslund Coach & Body Corp., also in Spokane.

Recently graduated from M. I. T., **ALEXANDER H. BOHR** has taken a position as junior engineer in the valve group at Reaction Motors, Inc., Dover, N. J.

ROLLIN ABELL is now associated with the Marshall Mfg. Co. in Bridgeport, Conn., as a designing engineer. This company manufactures the Abell carbureter.

Previously affiliated with the Bobbi Motor Car Corp., Birmingham, Ala., where he was chief body engineer, **FRANCIS H. CATALDO** is now a project engineer at the Tucker Corp., Chicago.

No longer associated with the Pump Department at Wilcox-Rich Division, Eaton Mfg. Co., Detroit, **RUSSELL H. BENNETT** is a service engineer at Chrysler Export Corp., same city.

V. J. JANDASEK has relinquished his positions as project engineer and chief test engineer with the McCulloch Motors Corp., Los Angeles, to become project engineer at Borg-Warner Corp., Bellwood, Ill.

Formerly of Purdue University, **ARTHUR W. CHRISTY** is now a test and development engineer with the Allison Engineering Division of General Motors in Speedway City, Ind.

JOHN C. BAINE, JR., who recently became vice-president and operating manager of the St. Louis Public Service Co., was formerly general superintendent of the Railway Department connected with the New Orleans Public Service, Inc., in New Orleans.

Before joining General Motors Corp. in Detroit as a design engineer, advanced power plant development, **ROBERT D. HARVEY** was a junior test engineer for Chevrolet-Flint Motor Division, Flint, Mich.

The appointment of **G. TAYLOR STANTON** as manager of engineering of Holtzer-Cabot Division, which is owned and operated by the First Industrial Corp., Boston, was announced recently. He has resigned as chief engineer of TelAutograph Corp. in New York City. Stanton designed the sound system in the General Motors' Futurama at the New York World's Fair.

GIFFORD A. COOK is now self-employed in San Francisco as a manufacturers' agent and engineering representative. Previous to this post he was sales engineer for Exacto Industries, Inc., in Los Angeles.

PAUL HOVGARD has been appointed general manager of the Piasecki Helicopter Corp., Sharon Hill, Pa. He will be responsible for the management of the Engineering and Factory Divisions and the Inspection Department. Hovgard had been an associate director of Cornell Aeronautical Laboratory.

B. J. VIERLING, JR., nationally-known aeronautical engineer and maintenance expert, has resigned as director of engineering and maintenance for Capital Airlines to assume the presidency of his own firm, Aircraft Advisors, Inc. Some of the services which the new company will offer are the selection and procurement of equipment, spare parts, tooling and facilities and the development of necessary engineering data.

DAVID C. PETERSON, former industrial consultant, has been appointed director of engineering and research at the main Chicago plant of Stewart-Warner Corp. Before joining Stewart-Warner, he was actively engaged as an industrial consultant to several large Diesel engine manufacturers, working on various phases on engineering and production.

MICHAEL SIPKO has accepted the position of assistant industrial engineer with the American Steel & Wire Co., Cleveland. He had been a development engineer for Jack & Heintz Precision Industries, Inc., Bedford, Ohio.

WILLIAM H. BULEN is now employed as a shop engineer on the bus assembly line at the Mack Mfg. Corp. in Allentown, Pa. He had been flight test analyst at the Consolidated Vultee Aircraft Corp. in San Diego.

A. W. (SKID) MACKIE was recently appointed general manager of the Pointer-Willamette Co., Inc., northwest trailer manufacturers. For a number of years, prior to joining the Portland Branch of Pointer-Willamette Co. in 1939 as service manager, Mackie was associated with the logging industry in the northwest. His advancement at Pointer-Willamette has been steady and rapid. Before his recent promotion he was production manager.

C. LEVON EKSERGIAN, who had been chief engineer of the Budd Wheel Co., Detroit, was recently made executive engineer, assistant to the vice-president on research, development and production engineering at the Budd Co. in Philadelphia.

C. L. CUMMINS, founder in 1919 of the Cummins Engine Co., Inc., Columbus, Ind., was recently elected chairman of the Board of Directors. Cummins, recognized throughout industry as the pioneer in the development of the high-speed diesel engine, founded the firm to build what was called the Cummins oil engine. By 1937 Cummins engines were in use in a wide range of jobs in the automotive, industrial, and marine fields.

ROBERT TWELLS, plant manager of the Spark Plug Division of the Electric Auto-Lite Co., was elected president of the Institute of Ceramic Engineers at their annual convention in Atlantic City on April 21. The Institute of Ceramic Engineers is a technical society consisting of graduate ceramic engineers, and is affiliated with the American Ceramic Society.

HAROLD MYERS has joined the Perfect Circle Corp. as a member of the central staff at Hagerstown, Ind. He will be associated with the chief engineer of the Mfg. Division. At the time of his departure to his new position, Myers was secretary of the Western Michigan Section.

L. H. SMITH has announced his resignation as vice-president in charge of engineering and new development of General American Aerocoach Co., Chicago. He had been responsible for the Aerocoach line of vehicles for both city and intercity service. Smith is going into business as a consulting engineer, and has been retained by the General American Aerocoach Co.

CHARLES W. DEEDS of Hartford, Conn., has been elected to the board of directors of Fairchild Engine & Airplane Corp. Director of several corporations, he brings to Fairchild a long background of aviation and industrial experience. Deeds recently resigned as president of Niles-Bement-Pond Co., and was formerly president of Chandler-Evans Corp.

Now a mechanical engineer with the H. K. Ferguson Co., Cleveland, **LOUIS F. FISHER** had been a development engineer, Kelsey-Hayes Wheel Co., Detroit. In his spare time Fisher is an amateur photographer.

Eaton Mfg. Co., Cleveland has formed three new Michigan divisions of the company to replace the former Wilcox-Rich Division. **F. H. MOTT, JR.,** who had been in charge of sales and engineering for the Rotor Pump Department of the Wilcox-Rich Division, has been made general manager of the Pump Division. He will maintain offices in Detroit where sales, engineering and research department for all three divisions will be located.

Announcement has been made of the promotion of **JOHN E. HENNINGSEN** from project engineer to the position of assistant chief engineer of the Road Machinery Division, Austin-Western Co., Aurora, Ill.

After relinquishing his position as chief chemist and metallurgist of the Buenos Aires Great Southern and Buenos Aires Western Railways, **H. N. BASSETT** has been appointed head of the Technical Division of Shell Mex Argentina Ltd.

Formerly students at Yale University, **ERNEST M. ZAISER, JR.** is now liaison engineer at the Hamilton Standard Propellers, East Hartford, Conn. and **LESLIE A. TOON** is an industrial engineer, Carnegie Illinois Steel Co., Homestead, Pa.

Prior to becoming chief of aircraft and aircraft engine salvage at Aircraft Conversion Co. (subsidiary of Brown-Root Co.) in Walnut Ridge, Ark., **FRED W. ZELLMER** was maintenance coordinator for the Southwest Airmotive Co. in Dallas, Tex.

FRED H. FIELDING of Washington, D. C. is now owner of his own business, under his name. He had been associated with the James A. Allan Co. In 1943 he was editor of Washington Section's "Spark Plug."

Having been works manager of the Frost Gear & Forge Division, Clark Equipment Co. in Jackson, Mich., **JOSEPH E. KRUG** was recently promoted to chief inspector of 4 plants of the Clark Equipment Co. in Buchanan, Mich.

SETH JOHNSON recently became research and development engineer with the H. L. Yoh Co., Inc., Philadelphia, consulting engineers. Previously he had been production engineer with the Kellett Aircraft Corp. in North Wales, Pa.

Prior to taking his present job with the Truck & Coach Division of General Motors Corp., Pontiac, Mich., **MAX E. WILDE** was connected with the Fisher Body Engineering Division of General Motors. He is on the membership committee of the Detroit Sportsman Congress.

Having served as an automotive engineer with the J. M. Steinhardt, Inc.,

Albany, N. Y., **C. W. MYERS** is now a salesman with Reo Motors, Inc., of that city.

P. M. HELDT, author and publisher of books on automotive engineering, recently issued a new, fifth edition of his book "High-Speed Diesel Engines." Completely revised, this book contains additional new material on diesel fuels, two-stroke and railroad engines, supercharging, and cold starting. To facilitate the book's already extensive use as an engineering text, Heldt added diagrams and complete explanations of both the two-stroke and four-stroke cycles. Other additions include illustrations of war-developed engines and a chapter on gas turbines.

Recently becoming treasurer of the Capitol Shellac Corp., Brooklyn, N. Y., **FRANCIS W. DAVIDSON** was a mechanical engineer at the Texas Co.

HAROLD H. HALL is acting general manager of the Cummins Diesel Sales Corp., St. Paul, Minn. He was a field service representative at the Cummins Engine Co., Columbus, Ind.

Preceding his appointment as manager of the Southeastern Research Institute, Inc. in Atlanta, Ga., **H. M. CONWAY, JR.** was an aeronautical engineer for the National Advisory Committee for Aeronautics, Moffett Field, Calif.

Promoted recently to sales manager at the Funk Mfg. Co. in Coffeyville, Kans., **H. A. COOK** will be responsible for all engineering and sales. Prior to this he had been chief sales engineer in the Industrial Division.

Announcement was made recently that **T. E. (TED) ALLEN,** assistant to the president on sales, will temporarily direct the sales of the Automotive Replacement Division. Allen joined Thermoid several months ago, prior to which he was executive vice-president and general manager of the Brake Lining Manufacturers Association. He is chairman of the SAE Committee on Brake Lining Standardization.

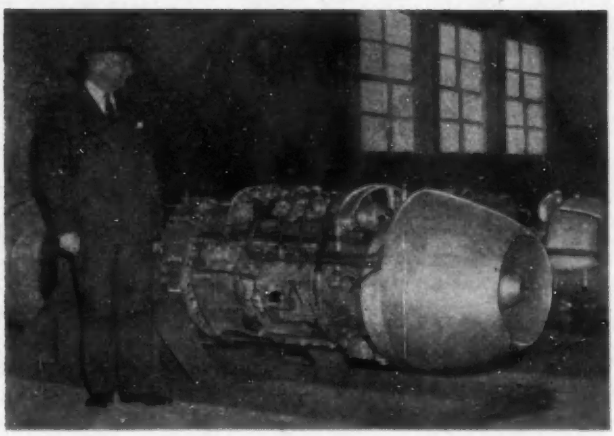
An intensive, one-week educational conference for college and university professors who teach courses in Diesel engineering will take place during the week of June 23, sponsored by the Diesel Engine Manufacturers Association. Fifty professors from all sections of the country will participate, including these SAE Members: Professors **FORD L. PRESCOTT,** University of Florida; **W. M. CARTER,** University of Kentucky; **G. W. HOBBS,** Michigan State College; **E. F. OBERT,** Northwestern University; and **C. P. ROBERTS,** Ohio State University. Also Professors **W. H. EASTON,** Oklahoma A. & M.; **E. M. SIMS,** Oklahoma University; **O. C. CROMER,** Purdue University; **VLADIMIR L. MALEEV,** University of Southern California and **L. A. WILSON** of the University of Wisconsin. The 50 professors who take part will follow a program that includes visits to engineering laboratories of the Illinois Institute of Technology and of Northwestern University, and factory tours of the General Motors plant at LaGrange and the International Harvester Co. in Chicago. Supplementing these inspection tours will be classroom talks on various Diesel engine topics.

PHILIP COSTA, engine instrument engineer for the Sperry Gyroscope Co., Inc. won first honors on April 22, in a prize paper contest sponsored by the American Institute of Electrical Engineers. His paper, entitled "The Knockometer, a New Instrument for Fuel Rating," was presented before that society's power and industrial group.

Having been associated with the Tide Water Associated Oil Co., New York City, as an automotive equipment and research engineer, **JOHN A. SAVAGE** is now senior automotive engineer with the Shell Oil Co., also New York City.

WALTER F. WRIGHT is now representing Jack & Heintz Precision Industries, Inc., and the Burgess Co., Inc., both of Cleveland, on sub-contract work.

Aircraft Engines of the World, 1947 edition by **PAUL H. WILKINSON** has just been published by the author at 216 East 45 Street, New York City. It presents complete specifications of all the latest aircraft engines in standardized page form facing full-page illustrations. All data is in English and metric systems of measurement. This new edition contains 352 pages.



HENRY C. PARSONS has relinquished his position as engineer with Parsons Industries in Traverse City, Mich., to become owner-manager of Rogers-Parsons Marine Service, Northport, Mich.

Recently employed as a consulting engineer with Gunnison Homes, Inc., New Albany, Inc., **C. E. PATTERSON** has become a development engineer at the Follansbee Steel Corp. in Pittsburgh. His new duties will entail the development of new products, plants and facilities.

LEONARD J. KOCH, who had been a project engineer for Jack & Heintz Precision Industries, Inc., Bedford, Ohio, has taken a similar position with the Tucker Corp., Chicago.

Having relinquished his position as mechanical engineer with D. W. Onan & Sons, **JOHN G. DAVIES** has been appointed chief engineer for the St. Anthony Machine Products Co. in Minneapolis.

No longer associated with General Motors-Holdens, Ltd., Pagewood, N.S.W., Australia, **GEORGE ELLIS** is now sales manager of the J-N-Kirby Pty., Ltd., Camperdown, N.S.W., Australia.

OBITUARIES

R. A. WATSON

A former chairman of the Northern California Section, R. A. Watson, died in San Francisco on April 6.

A member of the Society since 1936, he had been Western Representative, engineering and sales, of Federal Mogul Corp., and had served as the company's Pacific Division factory manager.

COL. VICTOR W. PAGE

Col. Victor W. Page died suddenly on April 1 after a brief illness.

He had been associated with the Norman W. Henley Publishing Co., New York City, for 36 years, and was the author of several books on the automobile and the airplane. His first book, published in 1912, was the "Modern Gasoline Automobile." This was one of the few books on the subject then in print.

Prior to his association with the publishing company, he worked with the Automotive Journal of Pawtucket, R. I., then joined the New Departure Co. of Providence, in an editorial capacity. From there Page came to Henley's as a staff writer. Some of his most notable works include the standard books on the "Ford V8" and the "Chevrolet Six."

He has been a member of the SAE since 1914.

SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
SUMMER	June 1-6	French Lick Springs French Lick, Ind.
WEST COAST T&M	Aug. 21-22	Biltmore Los Angeles
TRACTOR	Sept. 17-18	Schroeder Milwaukee
AERONAUTIC (Autumn)	Oct. 2-4	Biltmore Los Angeles
PRODUCTION	Oct. 20-21	Carter Cleveland
FUELS & LUBRICANTS	Nov. 6-7	The Mayo Tulsa
AIR TRANSPORT	Dec. 1-3	Continental Kansas City, Mo.
ANNUAL	Jan. 12-16 (1948)	Book-Cadillac Detroit

Student Branch News

College of the City of New York

Purpose of engineering is to produce the best for the least possible money, to the benefit of both consumer and manufacturer. This was the theme of Merrill C. Horine's talk before CCNY's student branch, March 20, on "The Engineering Process."

The sales promotion manager of Mack International Motor Truck Co. told students that in order to accomplish this end, some desirable features of a product often must be modified or even sacrificed to enable the embodiment of other good features. Judgment and compromise always are involved.

In mathematics, he said, we put our variables into one equation. We differentiate it and equate it to zero, solve, and have for an answer the maximum or optimum condition. In actual engineering practice, however, it is not so simple; there are too many human elements that enter into any problem and cannot be mathematically expressed. The only way to get somewhere near the correct answer is by intelligent use of judgment, experience and education.

Horine pointed out that a college education is a good way of absorbing basic knowledge. With this in mind, changes in present engineering curricula could produce a much improved system of education.

To make a product, design requirements first must be ascertained. Research may not always be the next step, but it is advisable to make use of others' research at this point. Next step is invention . . . not necessarily basic, perhaps improvements on existing products or designs. Engineering calculations come in with the actual design.

Experiment is another phase; this is more or less a check on human fallacy, as the most beautiful piece of development may be in vain if the engineer forgets some trivial item. Simplification, a part of engineering too often ignored, is the basis for putting something workable – from the standpoint of production, sales, maintenance, and so on – on the market.

Engineers have responsibilities beyond their technical activities, Horine said. The average engineer is relatively inarticulate, and the ability to speak well and clearly, in language intelligible to the layman, is essential to success.

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A visit to Worthington Pump & Machinery Co. in Harrison, N. J., was the highlight of the CCNY student branch meeting on April 7. Prof. Wilford L. Stork of CCNY made arrangements for the trip and pointed out particularly interesting processes.

They first went through the pattern shop where a large staff makes patterns, including specially interesting wooden ones for the intricate centrifugal pump housings. The pattern storage room, with its cross-indexing and filing systems, resembles an immense library.

In the foundry, several small sand molds and cores were made and assembled to illustrate the general procedure. A series of molds was lined up and poured. A large pit in the floor held a partially-completed mold and core of a centrifugal pump housing about 12 ft in diameter.

Among the more impressive operations seen in the machine shop were boring the inside of a 15-ft diameter, and turning a 12-ft crankshaft with a 3- or 4-ft stroke. Other processes were going on at the same time, such as flat drilling and boring a 12-in. hole 45 in. deep, some I. D. grinding on straps held to a few ten-thousandths on a 4-in. diameter, multiple key slotting in shafts, and various screw machine operations.

Final part of the trip was through assembly, where the group noticed that every piece of equipment is fully tested before shipping.

This tour was so interesting and educational that the student members hope in the future to visit as many Metropolitan area plants as possible.

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There are only two major fuel problems in designing an efficient internal combustion engine: how to get the fuel into the engine, and how to burn it. Both are difficult to do well, T. B. Rendel of Shell Oil Co., Inc., told the April 16 meeting of CCNY's student branch.

The ideal boiling range of a gasoline, he said, should be between 100 and 300 F – or, better yet, between 158 and 257 F. This is to prevent vapor lock in the fuel lines and to vaporize fuel easily in the combustion chamber. During an explosion, while the flame front of burning gases travels across the combustion chamber, it builds up the pressure of the unburned gases in front of it. This increase of pressure causes autoignition at a different point, and a second flame front fans out. When the two fronts meet, a knock is caused. This self-ignition is retarded by use of higher octane fuels. As a result, higher pressures are obtainable, giving greater powers.

As an illustration, Rendel said that in 1915 0.3 hp per cu in. was average on 70-octane gasoline. On today's 100-octane, almost 1 hp per cu in. is obtained.

Rendel described evolution of the present octane rating method, which he called already out-of-date, and which probably will be replaced in the near future by some more reliable method. He answered many questions, some about combustion chamber design, some about jet fuels – which are not yet troublesome, he said, from a fuel engineer's viewpoint.

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"Standardization is the foundation of our mass production economy," CCNY Student Branch members were told at their April 30 meeting, when Joseph Gilbert, engineering editor of the SAE Journal, spoke on "Your Stake in Industry Standards."

"Standardization," he said, "is a catalyst that promotes the well-being of every individual in this country. It offers better products more cheaply to the consumer, improves service repairs of those products, and broadens markets and the sales potential for the manufacturer's product."

He defined a standard as "a carefully thought-out method of performing a task, or a material or equipment specification, voluntarily agreed upon, that is cheaper or simpler for a majority of those producing the material or doing the job, as well as for those who will use either of these services, the material, or the fabricated product."

SAE standardization work, he explained, is under direction of a Technical Board of 24 leading engineers. These engineers represent the industrial activities encompassed by SAE – ground vehicles, transportation and maintenance, aircraft, air transport, diesels, farm equipment, and fuels and lubricants. The Board has 23 technical committees and some 140 subcommittees made up of nearly 2000 members.

Standards work falls into five categories: (1) dimensional standards; (2) performance specifications; (3) material specifications; (4) classifications or nomenclatures; and (5) testing methods.

Results, he said, emerge in reduced cost of many items; producer-user cooperation toward simplification of supply and maintenance problems; conservation of engineering effort by elimination of duplication of development and design of minor details; enhancing of the manufacturer's competitive position by permitting emphasis on critical characteristics related to performance and suitability of application rather than on minor details; and acceleration of industry progress by providing ethical and economical exchange of information.

Standardization, he said, remains beneficial only when it eliminates design variations that do not benefit the manufacturer or add to function or performance. If it begins to handicap progress and block advancement, it has gone too far.

But in its place, it is a service that cannot be measured in dollars and cents, because no one company could possibly collect the amount of engineering talent or the millions of dollars' worth of facilities necessary.

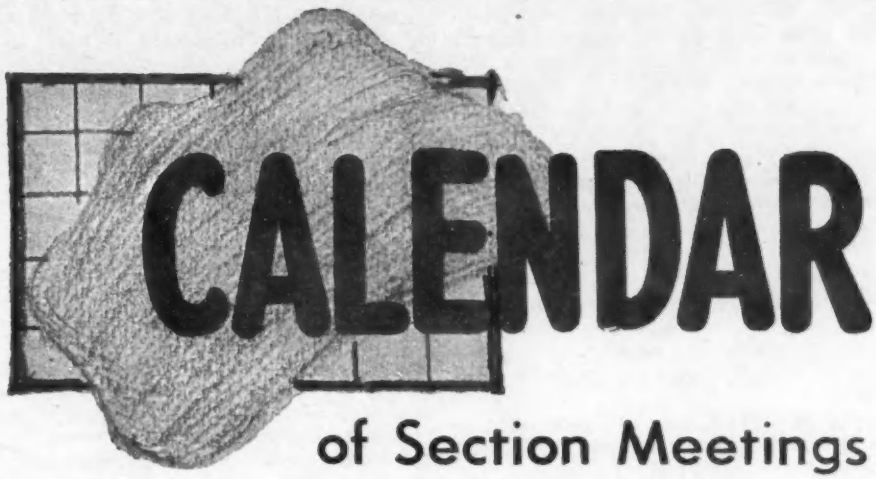
Student engineers were reminded that tremendous progress in standardization has by no means completed the task. They will have responsibilities, and, too, derive large benefits, from standardization still to be accomplished.

Texas A&M

R. F. Nelson, director of gas research for Texas Co., was speaker at the March 25 meeting of Texas A&M's student branch. He discussed the different processes in grease refining and the application of different types of greases.

March 31 started a three-day inspection trip conducted jointly by the SAE and ASME student chapters. The group spent the first day in Lufkin seeing Lufkin Foundries, Texas Foundries and the Southland Paper Mills.

On the second and third days the



of Section Meetings

British Columbia Group – June 11

Hotel Georgia, Vancouver; dinner 7:00 p.m. Speaker and subject to be announced.

Cincinnati – June 9

R. K. LeBlond Machine Tool Co.; dinner 6:00 p.m. Plant visitation of the R. K. LeBlond Machine Tool Co.

Cleveland – June 20

Pine Ridge; golf outing.

Detroit – June 20

Grosse Pointe Yacht Club; dinner 7:00 p.m. Dancing, door prizes and favors for the ladies.

Kansas City – June 4

Hotel Continental, Kansas City; dinner 6:30 p.m. Field trip inspection tour of General Motors Assembly Plant for Buick, Pontiac, and Oldsmobile.

Metropolitan – June 12

Hotel Pennsylvania, New York; meeting 7:45 p.m. Coordinating Mobile Diesel Equipment – A. T. Watts.

Milwaukee – June 7

Ozaukee Country Club; dinner 6:30 p.m. Installation of officers. Annual Ladies' Nite. Dance and entertainment.

Northern California – June 10

Engineers Club, San Francisco; dinner 6:15 p.m. Relationship of Good Fuels and Good Maintenance Practices to Operating Economy of Commercial Vehicles – E. J. Gay, manager, Commercial Engine & Fleet Division, Ethyl Corp., Detroit, Mich. Annual election of officers.

Peoria – June 9

Jefferson Hotel, Peoria; dinner 6:30 p.m. Track Type Tractor Performance – John Liggett, Allis-Chalmers Mfg. Co. Engine Maintenance in the South Pacific – J. C. Porter, Northern Regional Research Laboratory. Engine Design – Walter McCulla, Caterpillar Tractor Co.

St. Louis – June 10

Carter Carburetor Corp., meeting 8:00 p.m. Visit to Carter Carburetor Corp. carburetor service school.

Southern California – June 6

Truck and Bus Meeting. Speaker and subject to be announced.

group split into two smaller groups; one went to the Houston area to see Hughes Tool Co., American Can Co., Sheffield Steel Mill and the air conditioning system in the Humble Building, and the other to Dallas and Fort Worth to see Procter & Gamble, Dallas Power & Light, the Ford Assembly Plant, the Brown Air Conditioning Co., and the home of the new B-36 – Consolidated's Fort Worth plant.

Oklahoma A&M College

Automobiles set the pace for needs in better lubricants. In fact, it is the automobile industry that sets standards for the oil industry to meet, Dr. D. R. Frey told the April 14 meeting of Oklahoma A&M Student Branch. Frey, who is with the Research and Development Division of Anderson-Prichard Oil Co., defined lubricants and additives, and discussed the use of additives to modify lubricant properties. He commented on the trend toward universal lubricants and their application to gears and crankcases alike. Army maintenance records in World War II, he said, proved the maintenance value of a single lubricant for chassis and universal joints, and for the crankcases of different engines under a wide range of operating conditions.

George W. Cupit, Jr., secretary of the Mid-Continent Section, introduced Frey and spoke briefly on organization of various branch committees.

Massachusetts Institute of Technology

Rockets are no longer a "crackpot" subject, Dr. Hsue-Shen Tsien told MIT's April 9 Student Branch meeting. In their present stage of development, rockets have great practical value.

Choice of propellant, propellant feed system, and cooling combustion chamber walls are the three prime problems in rocket research, he said. Most efficient fuel for any particular rocket depends largely on the type of rocket, its size, duration of its powered flight, and the altitude at which it will operate.

Since the propelling force in a rocket motor depends on the velocity of the exhaust gases, the propellant should have a high cumbustion temperature and a low molecular weight, since these factors yield high velocity. Density of the fuel should be high to save space. These factors are general; in any given case one factor may be heavily stressed at the expense of others. For example, in the V-2, which is quite large and operates at very high altitudes, fuel density is not of primary importance, and is sacrificed to produce higher exhaust velocities.

Most widely used fuel today, the speaker said, is liquid oxygen in conjunction with either gasoline or alcohol. This gives an exhaust velocity on the order of 8000 fps. Rocket motors burn about 18 lb of fuel per hr per lb of thrust. Since the average rocket has a thrust of about 72,000 hp, it burns 360 lb of fuel per sec.

Fuel-feeding problems assume importance because of high consumption. There are two presently-successful methods: a pressure feed that, although extremely simple, requires keeping fuel under a pressure of 450 psi in a heavy fuel tank; and a pump feed, more efficient than the pressure feed but requiring power from a turbine using energy from part of the exhaust gases. Corrosive nature of the gases shortens turbine life. Sometimes a slow-burning propellant is used to force fuel into the combustion chamber.

Which method is used depends on the type of rocket; pump feed is most efficient for a large rocket, while either of the other two methods will prove more satisfactory in a small, short-duration rocket.

Final important problem in rocket design, the speaker said, is cooling of the combustion chamber walls. Most efficient types are film and sweat cooling. Both types use a thin liquid film, usually alcohol, on the inner surface of the combustion chamber wall, to dissipate heat. In film cooling, the liquid is fed in through fine holes in the combustion chamber wall; in sweat cooling, the wall is made extremely porous so that liquid seeps through. Sweat cooling has proved most effective in most installations.

Improvements in small details rather than radical design changes will bring about advancement, he believes.

Northrop Aeronautical Institute

April 17 meeting of the Northrop Student Branch was the largest to date: 103 members and 100 guests were present, all students at the Institute. Attraction was a unique group of films from Northrop Aircraft, Inc., showing highlights of tests run on recent Northrop designs . . . the B-35 Flying Wing bomber; N-9-M, small prototype of the B-35; XP-56, the first magnesium airplane; and Project 12, a prone-pilot type glider. The films were narrated by Jack Hathaway, who has been associated with the development of all wing designs for a number of years, and who is now an instructor at the Institute.

Purdue University

The gas turbine can compete with other forms of prime movers, M. J. Zucrow told Purdue Student Branch members at their April 17 meeting. Addition of auxiliary devices such as intercoolers and regenerators increase efficiency, although weight and cost jump. Particularly in large high-speed aircraft applications, turbines are superior to reciprocating engines.

Zucrow predicted future research will produce gas turbine designs with increasingly higher efficiency and longer life. His topic was "Development Possibilities of Gas Turbines"; he spoke at length on principles of turbine operation, historical development, and applications to stationary powerplants, ships, railroads and aircraft.

Before dinner, members made an inspection of the Purdue University airport.

General Motors Institute

Monthly meeting of the GMI Student Branch, April 8, consisted of a tour of Ethyl Corp.'s research laboratories in Detroit. Over 50 student members were present.

In the modern, well-equipped and well-maintained laboratories, Ethyl conducts experimental tests to determine the properties of fuels containing tetraethyl lead. These fuels are tested in different types of internal combustion engines under varying conditions.

In this way, the best fuel for a particular engine operating under specific conditions can be determined . . . or the best fuel for the average engine under average conditions can be found from the compiled data. New fuels are developed, and old ones improved, by using the experimental data as a guide.

Three main sections of the laboratories – chemical, automotive and aeronautical – are supplemented by a machine shop, carpenter shop, paint shop and automotive service garage.

Students were given an excellent insight into present-day methods of chemical and physical research conducted on fuels containing antiknock constituents.

Rensselaer Polytechnic Institute

"The Importance of Patents to an Engineer" was the title of a paper presented at the April 17 meeting of the RPI Student Branch by R. E. Hosley, patent attorney in General Electric's patent department.

Hosley explained the standards that determine patentability, and named as reasons for patenting an invention: (1) A patent enhances the commercial possibilities by making the product a safe investment for a corporation; (2) It increases the technical prestige of the inventor in his field, because a patent is "a certificate of originality"; (3) A patent permits the immediate publication of the discovery without fear that it will be used by some competitive firm or individual; and (4) A patent will encourage the development of the

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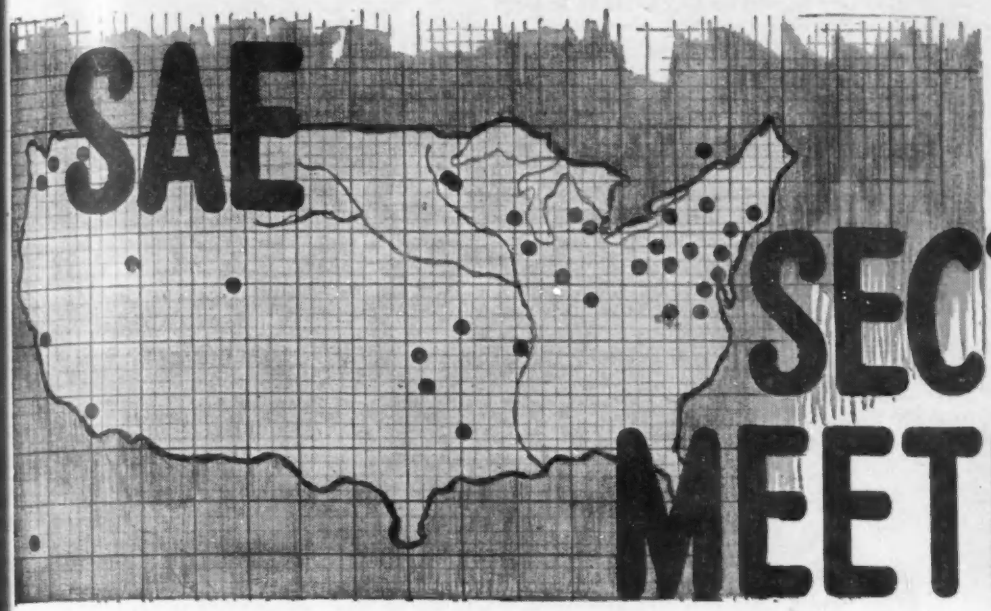


SECTION MEETINGS

GM Researcher Speaks On Propulsion Systems

by J. E. P. SULLIVAN, Field Editor

DAYTON Section, Feb. 19 – Fundamental requirements of an aircraft propulsion system were explained at this meeting by John F. Haines, director of research for GMC's Aeroproducts Division.

Haines discussed the advantages of each powerplant, and the proper application of each with regard to efficiency, power and speed. Each propulsion system has its place in the aircraft field, depending on the purpose for which the plane is designed.

Internal combustion engines have reached their peak in speed and altitude, he said; size and oxygen needs mark its limitations. Propeller-type aircraft has the advantage of quick take-off over the jet plane.

One of Dayton Section's largest crowds of the year attended the meeting and the social hour and dinner preceding it.

Advises Designers to Build-In Superchargers

by E. S. TOMKINSON, Field Editor

PEORIA Section, April 28 – "Supercharging is a misnomer," Kurt A. Beier of Schwitzer-Cummins Co. told this Section. "The addition of a blower merely brings the engine up where it should be."

Speaking on "Supercharging in Retrospect," Beier gave a resume of his 20 years' experience in applying superchargers to internal combustion engines.

Much trouble could be saved, he said, by designing an engine for supercharging from the start rather than attaching a blower as an afterthought. The blower should be driven from a point on the crankshaft close to the flywheel to avoid subjecting the blower to crankshaft torsionals. This is easy to arrange for in the original design, but if it is added to an engine not designed for it, the drive usually is from the front end, and torsional vibration trouble may be encountered.

Comparing centrifugal and positive displacement type blowers, Beier said that since efficiency of the centrifugal type falls off rapidly from its peak, it is not so good for variable-speed engines. The Roots type blower runs at slower speeds and is therefore less subject to drive troubles.

An engine with a blower usually will have slightly higher specific fuel consumption . . . but the output will be increased by 35 or 40%. An engine with low volumetric efficiency will receive considerably more benefit from a blower than one with good efficiency.

At dinner preceding the technical meeting, Erwin Bentz of Caterpillar Tractor Co. described his experiences as an observer with Task Force "Frigid" in Alaska.

San Diego Holds El Centro Meeting

by R. N. YEAGER, Field Editor

SAN DIEGO Section, Feb. 27 – San Diego Section is working toward formation of an SAE group in Imperial Valley, Calif. First meeting was held tonight in El Centro, with Frank Eiliott of Ethyl Corp. and Frank W. Fink of Consolidated-Vultee Aircraft Corp. as speakers.

Elliott spoke on "The Interrelation-

Northern California Section's Governing Board met April 9 to discuss plans for 1948. Shown here are members of the Governing Board and Nominating Committee: (standing) Field Editor J. H. Macpherson, Jr.; Section Representative E. J. McLaughlin. S. L. Boukard; F. W. Kavanagh, chairman of the Nominating Committee; H. J. Bihler; Central Valley Meetings Chairman V. E. Weiss; Vice-Chairman R. Wayne Goodale; S. B. Shaw; Secretary W. N. Nostrand; and R. A. Young. Seated are Reception Committee Chairman S. E. Onorato; Membership Committee Chairman J. E. Glidewell; Past-Chairman C. E. Becker; Jake, master of the wine cellar; Chairman C. A. Winslow; Staff Member E. W. Rentz, Jr.; Past-Chairman T. S. White; and Elton P. Fox, vice-chairman for Diesel Engine Activity

ship of Fuels and Internal Combustion Engines," showing with slides the progressive development of fuels and engines from early gas engines to the smooth-running powerplant combination of today.

Highlighting his talk was a film showing actual combustion taking place in the cylinder of a laboratory test engine. Pictures were taken at 40,000 frames per sec through a window in the cylinder by means of schlieren photography.

Fink, who is chairman of San Diego Section, talked about the Convair 40-passenger Model 240, using colored slides to show special features and styling of this modern air transport.

Urges Careful Welding Of Heat-Treated Parts

by J. B. TOMPKINS, Field Editor

BRITISH COLUMBIA Group, April 9 – While automotive parts are finding widespread use and application in industrial equipment ranging from cement mixers to material-handling devices, it is often necessary to completely build special assemblies such as transmissions, steering apparatus and clutches. So said Lloyd T. Graves, superintendent of Vancouver's Canadian Mixermobile Co., Ltd., speaking on "Application of Automotive Parts to Industrial Equipment" to British Columbia Group in Vancouver.

"With the present methods of machining with carborundum cut off wheels, carbide tools and diamond drills, it is quite easy to take off any excess material necessary to remove from a standard part," Graves told the SAE members and guests. "If the tolerance of the finished part is not critical it can be annealed to facilitate machining and re-heat treated with a possible saving in cost."

The speaker, in charge of production of industrial equipment including fork lift trucks, mobile concrete mixers and cranes, cautioned his audience to avoid welding of heat-treated parts unless it is possible during the welding procedure to keep wearing surfaces cooled. With proper welding equipment and facilities, alignment can usually be held to a minimum. But heat treatment of welded parts, he said, usually results in cracks or check marks in the weld and considerable warpage of the finished part.

Though in increasing use in industrial equipment, automotive parts at best are "on the weak side" in heavy equipment, he claimed. Designed for "the sake of compactness and competition," the horsepower ratings on motors often have little relation to the power needed for industrial equipment.

"Calculations of working loads should be overestimated, and part selections should be based on torque ratings," Graves said. "The use of automotive parts that have become obsolete should be avoided even though the initial cost of a machine is greater. This will pay dividends when it is necessary to replace a part, when the machine is to be duplicated or set up for production, or when parts lists and catalogs are being made up."

During the same meeting, Dr. G. S. Farnham of the International Nickel Co. of Canada Ltd. told the Group that in the steel-nickel alloy field, the present trend is toward low alloys. Among improvements in the automotive field with nickel Farnham listed exhaust manifolds and improvements in the properties of brake drums – particularly in heavy British Columbia logging trucks.

"Use of nickel in brake drums aids in reducing the stress on brake drums; cuts down fatigue and breakage," he said.

Metallurgist Tells Why Bearings Fail

by C. W. SISSMAN, Field Editor

SALT LAKE CITY Group, April 14 – Bearings are the serious limiting factors in the design and production of heavy, high-speed engines, according to John M. Stokely. Stokely, who is metallurgist and research engineer with California Research Corp., spoke at this meeting on "Engine Bearing Failure – Its Cause and Prevention."

Engineers' efforts to increase horsepower output and reduce engine size and weight and bearing size, he said, have only increased bearing trouble. Engine efficiency increases with higher temperatures, while bearing efficiency decreases.

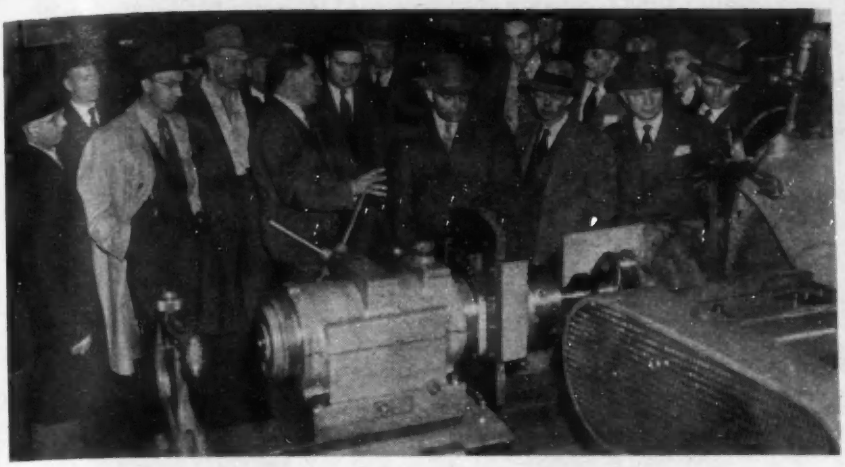
Excessive temperature is the major factor in oil corrosion rate in bearings, although tin and lead based babbitt bearings are best up to 200 F, the critical temperature for all bearings. Corrosion rate doubles with every 5 F rise above 230 F. Fatigue, too, increases sharply at this temperature. Cadmium-silver bearings will operate successfully at these higher temperatures, but cadmium-base bearings should be used only with corrosion-inhibitor base oils.

High oil and bearing temperature can be influenced by any of a number of abnormal conditions:

1. Plugged radiator or oil cooler.
2. Lugging, overloading, or overspeeding of engine.
3. Poor contact between bearing and bearing base or seat.
4. Plugged oil channels.
5. Insufficient clearances between journal and bearing.
6. Poor timing.
7. High oil viscosity.

Wilbur Shaw (right), president of the Indianapolis Speedway, is shown at a recent Indiana Section meeting with H. W. Dietrich (left) and J. Olender. Shaw is holding a model of the miniature car that Olender and Dietrich hope to build on a production basis as the world's best and fastest automobile

Buffalo Section Members Hear and See One Fleet Owner's Demanding Maintenance Problems



by R. J. MARBLE, Field Editor

BUFFALO Section, April 18 – One of this Section's most interesting dinner meetings and field trips began tonight at the Westbrook Hotel where W. W. Kunz, superintendent of equipment for International Railway Co., spoke on "Keep 'Em Rolling," or "What It Takes to Keep 95% of 685 Vehicles in Service Every Day."

Maintenance standards are necessarily high for a trucking fleet, Kunz pointed out. The operator of a trucking fleet looks for all the performance of the private car plus reasonable reliability in service and good fuel economy.

IRC's buses, he said, run on the average over 63,000 miles daily – better than twice around the earth. To keep performance close to 98%, the company employs nearly 600 men in two general overhaul shops and five garages, and spends roundly $2,500,000 a year for bus maintenance labor and materials.

Maintenance starts with selection of the vehicle, he said – selection of the proper vehicle for the job to be done. Accessibility is important; so is uniformity of equipment.

Preventive maintenance consists of servicing (gassing, oiling, cleaning and assignment to service); inspections and adjustments (source of the 98% performance: includes a biweekly tire inspection, a 2000-mile grease inspection, a 3000-mile ignition and running gear inspection, a 10,000-mile engine and power inspection, a 20,000-mile chassis inspection and a 40,000-mile unit change inspection); and performance records to prove the job is being done satisfactorily.

Overhaul and repair maintenance system has two general programs – the body overhaul and repair program, and the unit overhaul program in which units whose normal life bears no relation to vehicle body life are overhauled at times other than at the body overhaul period.

Overhaul and repair maintenance gives an opportunity for remodeling during overhaul, eliminating obsolescence and poor design. It also enables the engineer to use his ingenuity in the reduction of expense. Reclamation activities to reduce operating costs include welding, metal spraying, plating and sleeving of innumerable items and subassemblies.

After his paper, Kunz furnished two new buses to transport the guests through some of his maintenance shops, giving them a realistic illustration of his problems and methods of maintenance.

Predicts Trend Toward Automatic Transmissions

by C. E. BURKE, Field Editor

WESTERN MICHIGAN Section, April 24 – Patent files are jammed with ideas for automatic transmissions, Oliver K. Kelley told Section members at this meeting. The problem has occupied engineers for the past 40 years – but most patents are either unworkable or too complex to be practical.

Kelley listed seven basic types of mechanism with their advantages and disadvantages:

1. Mass inertia type: this uses a conventional ratchet and free wheeling clutch, and was about the first type used in an automobile. Principle is sound but clutch life is short.

2. Mechanical beam with a variable fulcrum: this too requires a ratchet and free wheeling clutch.

3. Hydraulic variable displacement pump: good features include ease and convenience with which tubing can be employed to transmit power from the engine to the wheels. Kelley pointed out, however, that if a high-pressure (5000 psi) low-flow system were used to keep efficiency high, oil leaks would become a problem; on the other hand, if a low-pressure, high-flow-rate system were used, the leak problem would be solved but oil friction would lower efficiency.

4. Electrical drive: this is probably the best method of multiplying torque, and does a job in the railroad field that a gear train would have difficulty in doing; but weight and expense preclude its use in passenger cars.

5. Friction drive transmission: this consists of a rolling member running on the face of a disc at a variable distance from the center. It has the advantage of smoothness and an infinite number of ratios.

6. Hydraulic torque converter: this has been invaluable in eliminating extremely frequent shifts necessary in city bus operation.

7. Gear type with a fluid coupling: this is made up of known parts, and consists in the automatic selection and shifting of specific gear ratios with smoothness acquired by the fluid coupling. In the type of automatic transmission used by Chrysler, shift can be accomplished only by letting up on the foot throttle. This simplifies the problem but results in a loss of acceleration. But acceleration loss is made up by a higher power-weight ratio.

Kelley believes two or three more years will show an overwhelming trend toward automatic transmissions in most passenger cars. In addition to their efficiency, they have a decided sales appeal.

HAMM

. . . . of Western Michigan

Douglas W. Hamm, chairman of Western Michigan Section, is as enthusiastically active in Section affairs as on the golf course. He plunges into Section administration as readily as he tells about the record-breaking trout he pulled out of Crystal Lake near Frankfort, Michigan.

He was one of the organizers of Western Michigan Section when it was still Muskegon Group back in 1943, a year after he became an SAE member.

Hamm was born in Muskegon, went to Muskegon Junior College and got his BS in chemical engineering from the University of Michigan. His first job was junior engineer for Muskegon

Douglas W. Hamm

Piston Ring Co. Now, at 30, he holds the important position of production engineer in a piston ring company located in one of the centers of the industry. His work brings him into contact with men many years his senior, and by the same token he is probably one of the youngest of SAE Section chairmen.

He has a two-year-old son who provides a good model for another favorite hobby – color photography.

– by C. E. Burke, Field Editor.

FINK

. . . . of San Diego

Frank W. Fink has been in on the ground floor of many vital projects since his graduation from the University of Colorado in 1928. It wasn't many years after he joined Curtiss Aeroplane & Motor Corp. (now Curtiss-Wright Corp.) as draftsman that he served as assistant project engineer on the experimental model of the P-40.

He joined Consolidated Vultee Aircraft Corp. in 1935 and moved with it to San Diego. He was design engineer in the powerplant group, later switching to the aerodynamics section. In 1938 he worked on Convair's Model 31 flying boat as assistant project engineer.

For the next two years he was project engineer on the XB-24 bomber, and stayed with the plane until it was being produced on the world's first mechanized, chain-geared assembly line.

In 1942 he became Convair's chief production engineer, and shortly thereafter chief division engineer. At war's end, when Convair's engineering departments in San Diego were consolidated, Fink was made chief engineer for airline and military airplanes, the position he now holds.

In his 12 years with Convair, he has gained the respect and confidence of everyone in the organization. His easy-going manner and friendly attitude almost belie the shrewd logic and extensive knowledge that have made him so successful.

Frank W. Fink

He applies his talents just as energetically to helping his two sons build model airplanes and tear down and rebuild automobiles. At his mountain retreat in Idlewild, weekends find him personally doing the work involved in installing a water system and an electrical system, building cabins and making a lake suitable for fishing.

Fink is slated to be general chairman of SAE's National Aeronautic Meeting in Los Angeles, Oct. 2-4. IAS, too, finds him a valuable member.

– by R. N. Yeager, Field Editor.

CLOSING DATE

SAE Journal strives, in these pages, to bring to Society members live, prompt news coverage of every Section meeting. Material is provided by Section field editors.

With dates determined by printing schedules, this issue covers all Section meeting news received in New York up to May 15.

TAYLOR

. . . . of Mohawk-Hudson

General Electric's Laurens ("Larry") Taylor is well known to his associates as a fireball when engaged in things that interest him – and few things don't. His work and his hobbies interlock . . . except for his gardening, and even that may be scientific.

Taylor has pioneered in most things electronic. One of his first assignments for GE after graduation from Cornell in 1923 was the development of high power shortwave telegraph and telephone transmitters. He helped build the first shortwave outfits for GE and cooperated with RCA in producing the first high power shortwave commercial transmitters. Later he was active

Laurens A. Taylor

in building transmitters at GE's radio station in South Schenectady.

He was an early bird with sound movies, and from 1928 to 1930 worked on development of the Photophone sound recorder.

An interest in aircraft equipment led him in 1930 into GE's marine and aeronautic design section. Since then he has been engaged in design and application of fire control systems, servo mechanisms, stabilizers, automatic pilots and other "gimmycracks" now used in military and naval aircraft. His part in radar and infrared detection systems began some 12 years ago and has been important.

Photography and high-fidelity sound reproduction are his own private projects.

Taylor has two daughters, one studying home economics at the paternal alma mater, the other in junior high school.

– by Gene O'Haire, Field Editor.

■

This is the ninth installment in a series of biographies of 1946-47 SAE Section chairmen. Next month three more field editors will report on their Section chairmen.

Rubber and Electronics Spotlighted at Meeting

by R. W. BIXLER, Field Editor

SOUTHERN CALIFORNIA Section, March 6 – SAE Members at this Production Engineering meeting heard about versatile electronic speed controls applicable to any size d-c motor, and learned of wartime improvements in synthetic rubber. B. F. McMamee of Electron Corp. spoke on "Electronic Speed Control of Motors in Industrial Application," and J. J. Robson of Firestone Tire & Rubber Corp. on "Synthetic Rubber in War and Peace."

In electronic speed control, McMamee said, the motor armature voltage can be regulated manually, mechanically, or electrically. Motor speeds can be regulated to less or more than motor rating. Power varies proportionally to speed, but torque remains constant.

These controls have four principal advantages:

1. Elimination of the motor-generator set with its accompanying maintenance, heavy foundations, and so on;
2. Higher degree of speed regulation;
3. Provision for including a simple overload control so that when current exceeds a certain value a tube reacts to stop further current increase;
4. Flexibility of design that makes them adaptable to any device.

Disadvantage is that the rectifier tubes must be water-cooled (at the rate of 6 gpm).

In answer to questions following his paper, McMamee reported that electronic speed control devices are portable, and give overall efficiencies of from 60-90%. They can be used with machine tools, but gearing down is preferable to reducing motor speeds if the horsepower output must be maintained.

Robson told of Army tests of GRS tires that subjected them to extremes in weather, rough roads, and so on, and described how defects were corrected. Cutting and chipping of treads was reduced by introducing crude rubber; heat buildup was cut by using rayon cord in the carcass; and resistance to impact was improved by increasing the number of plies – thus boosting mileage four to five times.

Robson bounced balls of natural rubber, GRS and GRI (Isobutane) for comparison. Natural rubber bounced about twice as high as GRS, and GRI had no bounce. But GRI is capable of holding air up to ten times as well as natural rubber, and although its wearing qualities are poor, it is an excellent material for inner tubes.

Turning to economics, Robson said United States synthetic production is more than three times that of the rest of the world. A world summary of natural and synthetic rubber production shows a production capacity of 3,400,000 lb per year and a consumption of 1,500,000 lb per year. Price of natural rubber has ranged from 3¢ per lb in depression years to $1.25 in critical shortage years. He believes synthetic production will help level prices.

Comparing German with United States synthetics, Robson reported two main disadvantages of the former: they require an oven treatment of 50 min at 200 F before they can be processed, so that production is slow; and they have a bad odor.

SAE Members Tour Large Wind Tunnel

by A. M. WATSON, Field Editor

SOUTHERN NEW ENGLAND Section, April 2 – Despite a driving rainstorm, about 125 SAE members made an enthusiastic tour of United Aircraft Corp.'s wind tunnel in East Hartford. The tunnel is capable of testing full-scale powerplant installations at air speeds of 200 mph, as well as reduced-scale models of aircraft and propellers at air speeds of 600 mph.

It is the largest closed-circuit type tunnel ever constructed of reinforced concrete, and the largest private wind tunnel in the world. It can test engines of up to 4000 hp, equipped with propellers as large as 17 ft in diameter.

Ken Thomas presided at the preceding dinner, and John G. Lee, assistant director of United Aircraft Research, made a few preliminary remarks about the scope of the wind tunnel.

Predicts Home Luxury In Future Bus Travel

by ROBERT INGRAM, Field Editor

WILLIAMSPORT Group, April 7 – "Snack bars, individual radios, and even a stewardess will be part of the bus of tomorrow," W. E. Williams predicted at this meeting.

Williams, who is development engineer for ACF-Brill Motors Co., spoke on "The Trend of Future Bus Design." Reviewing bus development for the past 30 years, he said the first buses were box-like contraptions riding on solid rubber tires, propelled by poorly-muffled engines that produced clouds of obnoxious smoke.

From this early beginning, bus manufacturers and operators in the early 20's introduced rubber tires and padded seats, rounded off blunt corners, added four-wheel brakes, made steering im-

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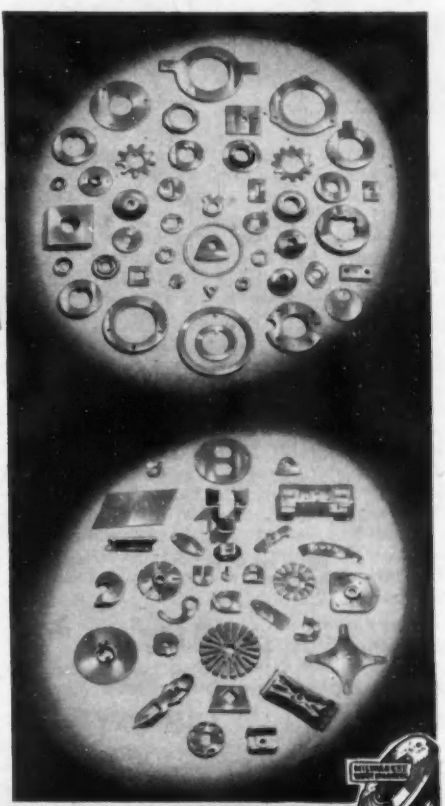

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provements, and adopted monocoque or integral body construction.

Most important change, Williams feels, came in the early 30's when engines were moved from front to rear, so that great improvements in body styling could be made. The driver's vision improved when he was moved to the extreme front. Chief improvements since then have been balloon tires, reclining seats, more adequate heating and lighting, and power ventilation and air conditioning.

"The bus of tomorrow," Williams said, "will be a vehicle approximately 35 ft in length with sleek, smoother lines, but about the same profile as present buses. Inside, you will find wider aisles; larger seats with deep, comfortable upholstering; fresh air of just the right temperature; rest room facilities; radio at each seat; a stewardess ready to provide drinks or lunch; large windows; and, last but far from least, a happy, smiling driver who considers it a pleasure to drive this ultra-modern, easy-to-handle, two-way-radio-equipped bus with a powerful engine and an instrument panel that does all but reach up and tap him on the shoulder if anything goes wrong."

Discussion aired the value of aircraft engines for bus service. Williams believes they cannot compete with bus engines. But, he said, ACF-Brill is equipping one of its buses with an aircraft engine to determine obtainable length of service. The group was interested to learn that weight saving means little to bus manufacturers. A saving of 1 lb weight, Williams estimated, is worth about 50¢.

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Frigidaire Is Host To Dayton Section

by J. E. P. SULLIVAN, Field Editor

DAYTON Section, April 17 – Frigidaire Division of General Motors Corp. was host to the Dayton Section tonight for dinner and a trip through the Moraine City plant.

S. M. Schweller, chief engineer of Frigidaire, welcomed 170 members and guests in the plant auditorium, and discussed the varied lines of products manufactured by Frigidaire. E. F. Schweller, manager of the Household Engineering Division, talked about the cold-wall household refrigerator, and showed a moving picture called "Simplest Refrigerating Mechanism Ever Built." George Pearce, section engineer of the Appliance Engineering Division, discussed the Frigidaire electric range.

J. L. Gibson, manager of the Commercial & Air Conditioning Engineering Division, showed the group a representative commercial condensing unit and forced-air cooling coil, and explained their use and application. They also saw a new 8-cu-ft home freezer for freezing and storing frozen foods.

After viewing a complete display of company products, the group made a thorough tour of product fabrication and assembly layouts.

Outlines Problems In Three Sonic Ranges

by J. H. MACPHERSON, JR., Field Editor

NORTHERN CALIFORNIA Section, April 8 – Mach and Reynolds numbers and their effect on airfoil design were discussed at this meeting by Donald J. Graham of NACA's Ames Aeronautical Laboratory.

Graham is now in charge of a transsonic wind-tunnel section concerned with problems of airfoil section design, airfoil control surface behavior, and the stability and control of airplanes at transsonic speeds. He presented his topic in three sections: the use of Reynolds number as a design parameter to develop low drag airfoils in the subsonic speed range; the present status

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Colorado Group – No appointment
Mohawk-Hudson Group – Gene O'Haire
Salt Lake City Group – C. W. Sissman
Spokane Group [redacted]
Virginia Group – Jean Y. Ray
Williamsport Group – Robert B. Ingram

[redacted] IT is with deep sorrow that we report the death of Loring Harvey Meacham, field editor for Spokane Group, in a recent plane crash in Idaho. Loring had been superintendent of transportation for Bunker Hill & Sullivan Mfg. Co. in Kellogg, Idaho, since his graduation from the University of Idaho in 1926. He joined SAE in 1945.

of research in the supersonic speed range; and the difficulties encountered in present research in the transsonic speed range.

Reynolds number, Graham explained, is a parameter relating density, viscosity, velocity, and a characteristic dimension of the fluid flow under investigation. Reynolds number can be used to determine the flow condition at which the flow will change from laminar to turbulent type.

In early research work on airfoils, he said, it was assumed that airfoil drag was caused principally by the setting up of turbulent flow patterns around the wing. But subsequent research has indicated that drag comes mainly from friction in the layer of air adjacent to the wing surface. Proper design of the airfoil profile can make flow around the wing laminar, thus reducing drag.

The laminar-flow wing differs from conventional airfoils in that its thickest point comes much closer to the trailing edge than in previous designs. If the laminar-flow wing is used at proper angles of attack, it is possible to reduce drag by 50% over previous airfoil designs. This spectacular reduction means a tremendous increase in range and speed as exemplified by the North American P-51 Mustang fighter, whose performance greatly surprised the German Air Force during the last stages of World War II.

As for research, NACA is systematically testing all possible shapes of airfoil to find the most suitable design for operation at various Mach numbers in the supersonic range. Graham explained that the Mach number is simply the ratio of the speed of flight to the speed of sound at the temperature of the surrounding air.

The subsonic range is arbitrarily taken from 0 to 0.85 Mach number, while the supersonic range goes from 1.15 up. In the supersonic range, he said, very thin airfoils and sweptback wings are most suitable. For moderately high Mach numbers (in the range of 1.15 to 1.8) rounded leading edge airfoils similar to those in the laminar-flow subsonic design can be used successfully. For higher Mach numbers (from 2 to 3 and up) the leading edge must be razor sharp. Plan form of the wing must be a swept-back design to attain stability.

Theory of airfoil design in the supersonic range has been well-developed, Graham said, and design considerations in this region are considerably simpler than they are in the subsonic range. In the transsonic range, however, very little experimental work has been done and no satisfactory theory for predicting performance has been developed.

NACA research, he reported, is directed toward achieving supersonic flight and stable flight in the trans-

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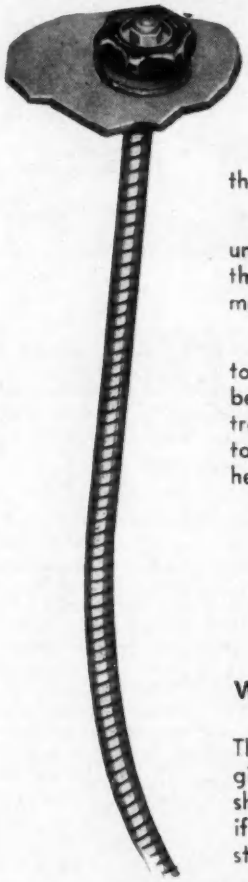

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sonic region. Not completely explored are problems of pilot safety and other operation difficulties certain to be encountered. These will be the subject of further research once supersonic flight has been achieved.

In the discussion following Graham's paper, W. V. Hanley of Standard Oil Co. of Calif. commented on some of the hazards pilots will encounter in operating supersonic aircraft. If a power failure occurs at supersonic speeds, the aircraft will of course decelerate. Because drag increases as speed drops from supersonic to transonic, deceleration will increase rapidly as the speed of sound is approached. Calculations indicate this deceleration could be of the order of 30g. Such a force naturally would cause serious physical damage to the pilot. It has been proposed that decelerating rockets be carried for such emergencies to avoid too rapid deceleration.

W. W. Davies, of United Air Lines, Inc., asked about landing problems with supersonic aircraft. He felt there would be very serious operational difficulties in landing these aircraft at 120 mph, but did agree that supersonic flight problems would have to be solved before such operation problems could be seriously studied.

Fellows Films Show Lucite Gears at Work

by ROBERT B. INGRAM, Field Editor

WILLIAMSPORT Group, May 6—Members at this meeting saw a two-reel sound motion picture on "The Art of Generating and Gear Manufacturing Equipment," presented by Fellows Gear Shaper Co. In these films, straight polarized light showed the nature of gear tooth action and contact. This was accomplished for the first time from a Fellows-conceived test set-up using Lucite gears in combination with mechanical loading used to simulate actual operating conditions. Defects were shown up by a flare of light as the teeth passed through mesh.

The first reel covered principles of transmitting rotary motion; gear theory; gear design; gear action and contact; and applications of the generating principle. "Generating" is a term used to explain the development of a line or surface. A point moving through space generates a surface.

Application of this principle showed how it can be adapted to the machining of a variety of surfaces. A single-point cutting tool was shown generating a cylinder, an elliptical surface, a cam, and a plane surface. Also shown was the generation of a rectangular hole.

The second reel showed gear cutting and finishing equipment, gear measuring, and testing equipment. Of special interest to the group was the elaborate gear measuring and testing equipment. Instruments were shown for graphical

recorded inspection of involute tooth profiles and helical surfaces (helix angle, lead angle, and lead).

Characteristic charts were included to show how tooth displacement from the desired helix can be accurately determined, and to show crowning and taper of spur and helical gear teeth. Errors are charted and magnified 500 times.

Pittsburgh Section Sees Miller's Combustion Films

by MURRAY FAHNESTOCK, Field Editor

PITTSBURGH Section, April 22 – A large number of Pittsburgh Section members attended the dinner given at Webster Hall Hotel in honor of C. D. Miller, and 130 heard him explain his photographic studies of combustion in ultra slow motion at the Mellon Institute.

Miller, who is from NACA's Aircraft-Engine Research Laboratory, summarized seven years of research on combustion and knock in engine cylinders with the use of ultra-high-speed cameras operating at 40,000 and 200,000 frames per sec. Investigations were made at NACA laboratories and at Langley Field.

Urges Modern Foundries For Improved Castings

by L. A. WILSON, Field Editor

MILWAUKEE Section, May 2 – One of Milwaukee Section's biggest meetings of the year began with an afternoon inspection trip of the Nash plant in Kenosha, included dinner at Dania Hall, and ended with a talk by Arthur A. Weidman, director of quality and inspection at GMC's Detroit Diesel Engine Division.

Speaking on "What's Wrong with Cast Iron," Weidman described the castings industry as confused because engineers, foundries, consumers, and others involved have failed to get together and come to mutual agreement about what is needed.

For better castings, Weidman suggests:

1. That engineers work with foundrymen on the design of castings;
2. That purchasing departments select adequate sources and expect to pay reasonable prices;
3. That manufacturing departments stay flexible enough to handle occasional mis-runs;
4. That inspection groups be thoroughly trained to determine quality castings and to classify foundry defects in terms that describe accurately and are understood by the foundry;
5. That foundries modernize by bringing plant, facilities, and personnel up to date, making management policy more aggressive, and promoting an educational program to advertise the importance of foundries.

C.E.D. Speaker Describes Role of Economic Research

by W. F. SHERMAN, Field Editor

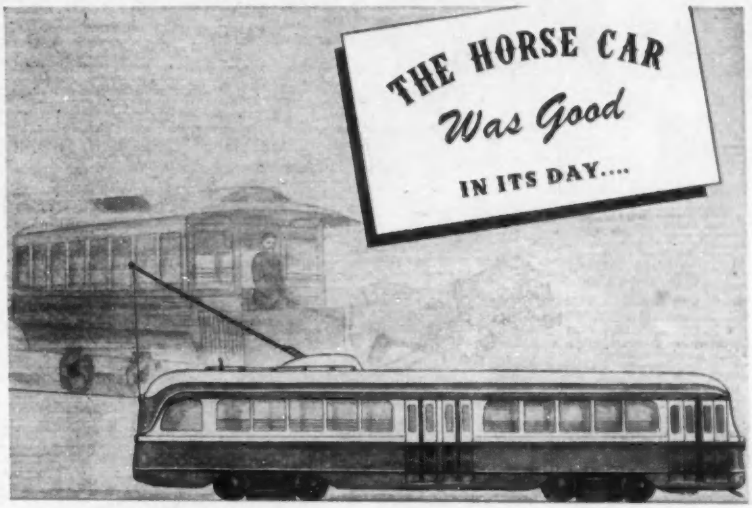
DETROIT Section, April 7 – The broadening of engineering horizons by research in fields of economics was described at this meeting by J. H. Van Deventer, director of information for the Committee for Economic Development.

Aladdin and his lamp, with the help of the genie, could not have built the equivalent of today's industrial plants, power, equipment, materials handling systems, and other engineering and production marvels, Van Deventer said, because, even with the lamp, Aladdin had to visualize what he wanted before the genie could bring it for him.

It would have taken Aladdin longer merely to think up these marvels than it has taken all our engineers to think of them, write specifications, and get them built.

However, just as Aladdin had to guard against the genie's "taking over," so we must be on guard to protect ourselves from the "widening swings of boom and bust," he said.

Some people can't refrain from



BUT . . .

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throwing monkey wrenches in a machine. Hence, under similar circumstances, some other countries have succumbed to a planned economy "whose best is scarcely equal to our worst."

Van Deventer described the CED as an organization of business men who believe that the best way to guard against catastrophe is by broadening our economic horizons so that our knowledge of how to run our machines will equal our design ability.

Money must be spent on economic research on the simple basis of "get the facts or they will get you," he asserted. The first step is to get a perspective of progress and its rate of acceleration.

The machine age is in its infancy, but in it we have failed to study the relationships of man to man, government to industry, and so on. CED believes this cannot be done by turning our economic research and thinking over to a Government agency. Instead, it is employing economic specialists to engage in objective research, cross-checked by practical industry people. He described CED functioning in detail.

Coffee speaker was George Cushing, Station WJR's news editor, who described the news editing task and gave a colorful picture of the personalities and problems he encounters in staging a weekly program "In Our Opinion," which draws upon numerous authorities to present interesting aspects of controversial questions.

Reviews Progress In Gear Lubricants

by H. D. YOUNG, Assistant Field Editor

CHICAGO Section, May 13—Hypoid lubricants and the tools for testing them were subjects of an informative paper presented tonight by W. B. Bassett, head of Lubri-Zol Corp.'s technical service department.

Bassett reviewed overall developments in gear lubricants since the introduction of hypoids. Changes in design and, in particular, the increase in rubbing speeds and tooth loading per unit area have dictated certain changes in the composition of such lubricants.

But basic requirements for a satisfactory lubricant, as exemplified by the U. S. Army 2-105B specification, are about the same as when hypoids first were introduced.

Bassett said that efforts are now being made to establish laboratory dynamometer tests which will correlate more closely with field tests.

In conclusion, he said:

1. Some changes in the 2-105B axle test procedures may be desirable for closer correlation with road performance;

2. The specification does not depend on chemical composition or bench tests for defining satisfactory gear lubricants;

3. The 2-105B specification was developed through the cooperative efforts of technical personnel from both the automotive and the oil industries; and

4. The 2-105B specification is fundamentally sound since it is based on gear lubricant performance in high speed-low torque and high torque-low speed axle tests, and does not include other tests which have failed to correlate with service.

H. L. Moir of Pure Oil Co. and Norman Penfold of Armour Research Foundation presented prepared discussions of Bassett's paper. Moir emphasized the soundness of the 2-105B specification. Penfold stressed the fact that despite improved surface finishes and metallurgy in gear manufacture, only slight performance gains may be expected.

On the other hand, a great deal may be done with lubricants, and the petroleum chemist is in a fine position to make a major contribution to the knowledge of gear lubrication.

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Student Branch News

cont. from p. 84

discovery by safeguarding the company's investment during the research period.

The inventor, he concluded, should first write a clear, lucid description of his device or process and its operation, with a well-labeled sketch. This should be signed and dated by competent witnesses to establish date of conception.

A good patent attorney makes a search of Patent Office files to establish originality and patentability of the device, and will defend validity of the claim before a hearing by the Patent Office investigator.

New York University

George Bleyle of Wright Aeronautical Corp. spoke to NYU's April 22 student meeting on the problem of cold starting of aircraft engines. Bleyle, who has supervised research on this problem both in controlled experiments in a refrigerated test cell and in field operations, explained the urgent need for suitable procedures for cold weather starting in peacetime as well as in war, inasmuch as long distance flights in the northern hemisphere must approach the north pole if they are to follow the economical great circle routes.

Cranking difficulties at low temperatures must be overcome to improve quick-starting ability, and quick take-offs are needed to prevent fouling of the spark plugs, Bleyle reported.

He explained a schedule of minimum cranking speeds necessary to start engines at various operating temperatures, and indicated how, by temporary oil dilution, it is possible to obtain such cranking speeds.

He suggested that further development of the new synthetic oils which are coming into widespread use may solve some of the lubrication problems at extremely low temperatures.

•

On May 7 and 9 NYU's Student Branch sponsored a trip to the Socony-Vacuum plant at Greenpoint, Brooklyn. ASME and IAS Student Branches joined the tour. Thirteen members went on Wednesday under the leadership of SAE Chairman Herbert Jaffee, and 25 on Friday with George Sonnemann, SAE secretary-treasurer.

Both groups were met by Dr. Brown, who briefly outlined the work done at Greenpoint, and divided the group into four sections under the guidance of Messrs. Dean, McCale, and Houghtney and himself. The groups spent an hour inspecting engine testing and fuel test laboratories.

Oklahoma A&M College

Speaker at the May 5 meeting of the Oklahoma A&M Student Branch was Arch L. Foster, refining editor of the Oil & Gas Journal. Foster spoke on "New Developments in Aviation and Automotive Fuels."

The human race always does best under stress, he said, and World War II compressed 15 years of fuels progress into three years. However, octane numbers have not risen in accordance with 1944 predictions, because catalytic cracking capacity is small and lead compound supplies are limited.

Foster discussed relative merits of gasoline produced by the thermal and catalytic processes, and wound up with a discussion of the Fischer-Tropsch process. He revealed that there are two plants now being constructed for this process in the United States.

One in Texas will start with natural gas at 2400 F, and, using an iron powder as a catalyst, will produce gasoline in a continuous flow process. This gasoline will run between 70 and 85 octane,

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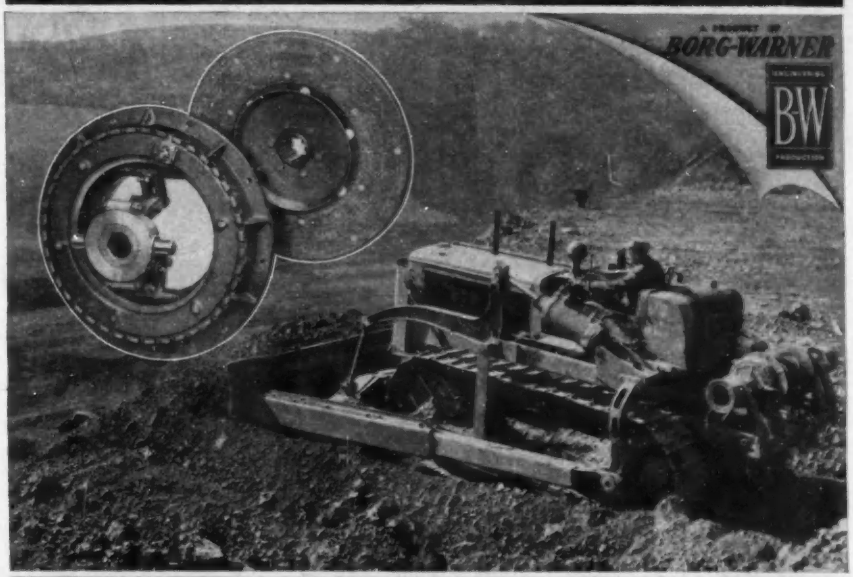

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and diesel fuel will run between 45 and 55 cetane.

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Lawrence Institute of Technology

Nearly 70 members of L.I.T.'s SAE Student Branch made a tour of Chrysler Corp.'s engineering laboratories in two groups – one on March 24 and another on March 25. Kenneth Loring of Chrysler arranged the tour, and students of Chrysler Engineering Institute served as guides.

Main points of interest for most of the students were the fluid drive laboratory, physical test laboratory, plastic research laboratory, powder metallurgy, induction heat treating processes, and the X-ray laboratory.

Plans are being made to schedule another tour of Chrysler Corp. for members whose class schedules interfered with this one.

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About SAE Members

cont. from p. 81

A. T. COLWELL has been elected a director of the American Coach & Body Co., Cleveland, **JAMES HOLAN**, chairman of the board, announced.

The Francis Co., engineers and designers, have moved into their new offices at 222 North Michigan Avenue, Chicago, according to a recent announcement from **JOSEPH S. FRANCIS**, president.

Prior to becoming a service representative with the Lincoln-Mercury Division, Ford Motor Co. in Chicago, **JOE M. MILLER** was in the Army Air Forces at Wright Field.

No longer associated with the Consolidated Conditioning Corp., New York City, **MAURICE BENTON** is a design engineer, Jaros, Baum & Bolles, same city.

L. A. BIXBY and **E. M. SCHULTHEIS**, veteran automotive men long connected with Clark Equipment Co., Buchanan, Mich., were elected vice-presidents of the company at the recent annual meeting of the board, it was announced by **GEORGE SPATTA**, president.

Now chief of administration at the Boston AAF Procurement Field Office, **SIDNEY KAUFMAN** will be responsible for all of the administration details of the whole organization. Previously he had a similar position with the Army Air Forces Institute of Technology, Wright Field.

Having been discharged from the U. S. Army, **ROBERT E. ARNDT** is a student at the Ohio State University, Columbus. He is studying for a PhD in engineering.

IVER THEODORE ROSENLUND has become a research engineer with the E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Prior to this he was a project and development engineer, Gas Turbine Combustion Chambers, Packard Motor Car Co., Toledo.

"It will become possible within the next five years for aircraft to operate in every part of the world with the same systems of radio guidance and the same instrumentation," **DR. EDWARD WARNER** predicated at the International Civil Aviation Organization's First Assembly Meeting in Montreal. "Once having attained that uniformity," he added, "the world will never again suffer it to be lost." Warner's statement was made in presenting the annual report of the Interim Council, of which he is president. He is a past-president of the SAE.

Personal Plane Meeting

continued from page 32

Still other powerplant studies at the Wichita meeting involved a tiny "outboard motor" designed for converting sailplanes into power gliders, and helicopter powerplant design problems.

The supplemental power glider motor which is designed to provide 22 hp at 4500 rpm with a reduction gear which turns a propeller at 2 to 1 ratio, is designed to be attached to a glider in pusher arrangement. The propeller is designed to fold against the engine for reduction of drag when the engine is not being used. Total weight of the installation on the glider is 80 lb and results in a slightly increased sink and stalling speed and wing loading, and a decrease in the gliding ratio from 19 to 1 for the glider without the powerplant to 18 to 1 complete with power unit.

Advantage of being able to turn the helicopter engine crankshaft at a higher speed results in a 25 to 30% increase in power from a given engine when used as a helicopter powerplant over what is available in a similar engine used as a fixed wing aircraft powerplant.

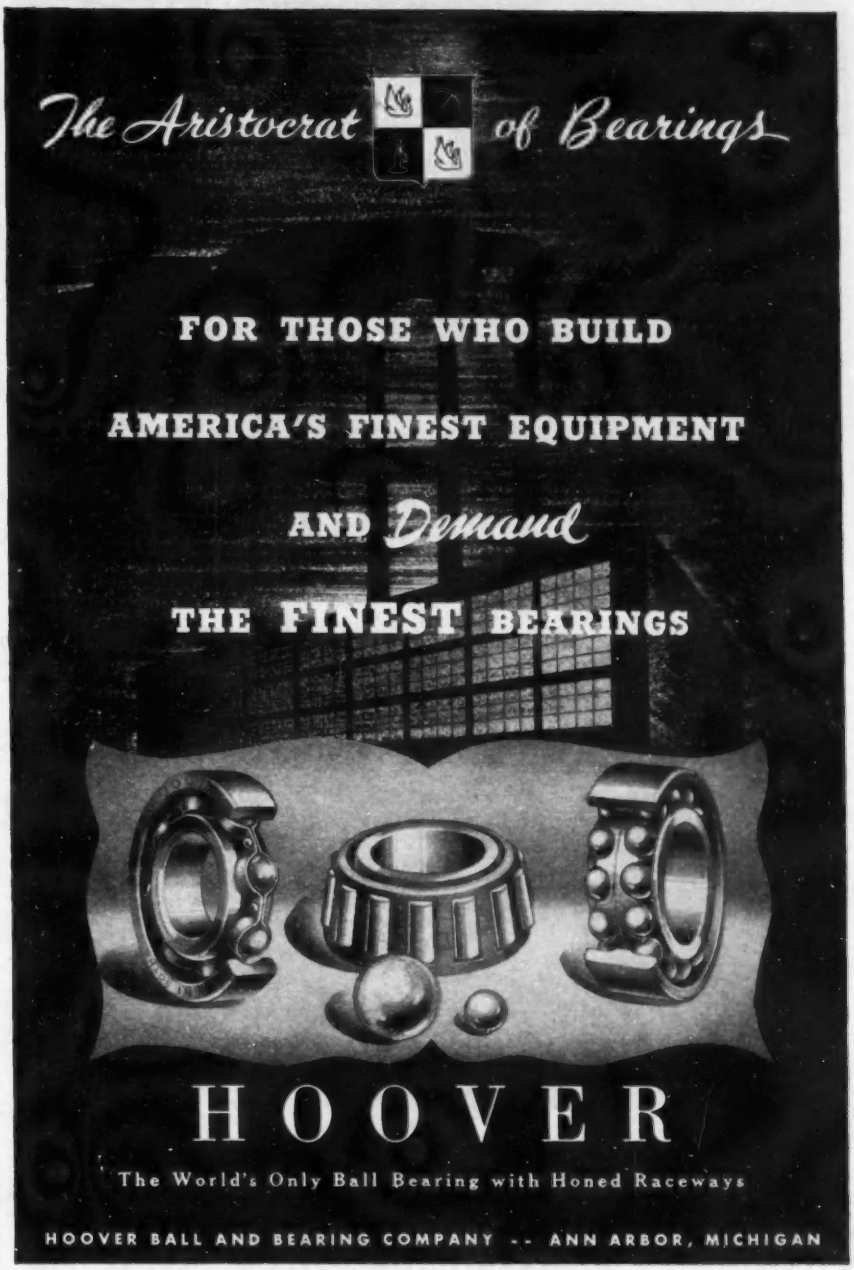
This is explained by the fact that a reduction gear is required between the helicopter rotor and engine, in order to avoid critical rotor tip speeds, and the extra power is obtained by a further increase in the reduction ratio. Best opportunity for further weight reduction lies in substitution of magnesium for aluminum in crankcase and accessory castings.

Superior machining qualities of magnesium promise to offset the slight increase in material cost, and the weight savings for material in a crankcase of a 250 hp engine runs to about 20 lb. A comparison of two engines of basic fundamental structure, one of which used magnesium wherever possible and was turned at a 3200 rpm crankshaft speed, showed that the conventional engine weighed 340 lb, and had a gross rated power of 185 hp while the lightened engine for a helicopter produced 270 hp and weighed only 304 lb, with an advantage in pounds-horsepower ratio of 1.111 to 1.840 for the heavier engine.

Importance of simplifying helicopter controls was urged, in the discussion of a new proposed means of longitudinal and lateral control not requiring cyclic pitch control, which is blamed for a large factor in the complications of present day helicopters.

Advantages possible in the use of new materials for blades of light plane propellers, such as laminated glass plastics, which are now being experimentally investigated, were discussed. It was estimated that a savings of one-third in blade weight might be achieved, which would make possible new methods of machining the propeller hub, at lower cost, if additional weight could be added at the hub. Studies of performance characteristics of small planes with fixed pitch and controllable pitch propellers were compared. It was concluded that the automatically variable propeller was the simplest form and that it or the simple two-position controllable propeller is to be preferred for airplanes with low wing loadings and relatively high power loadings. Higher performance airplanes will probably require constant speed or selective pitch propellers.

Standardization of mounting flanges in the present SAE standard system was called for, although it was pointed out that present SAE flanges inflict a weight penalty on smaller designs. Controllable pitch propellers should be produced at approximately $1 per hp in the smaller sizes.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Use of variation of thrust as the principal pitch changing force for an automatically variable pitch propeller was described in the review of a development program which has resulted in production of such a propeller for light planes (Aeromatic). More than 5000 of these propellers in varying sizes are now in the field.

Need for joint effort by airplane, engine and propeller manufacturers to overcome the problem of airplane noise, was urged. Use of automotive experience in muffler development, smaller diameter propellers and reduction gearing will be factors in the reduction. Cost of multibladed controllable propellers makes their acceptance questionable except in cases where noise reduction is imperative, it was stated.

A review of the V-tail empennage, which takes the place of conventional vertical and lateral control surfaces, pointed out among advantages reduction in total area, reduction in intersections to four, less trim change, use of only two interchangeable surfaces, and making possible an airplane that was essentially two-control and spin resistant.

Possibilities in the unconventional field of flapping-wing flight with emphasis on the study of insect wings was described, as a stimulus to more original thinking by aeronautical engineers. Wing-loading of insects is greater than that of many birds and the insects move their wings rapidly and make higher speeds proportionately, it was reported.

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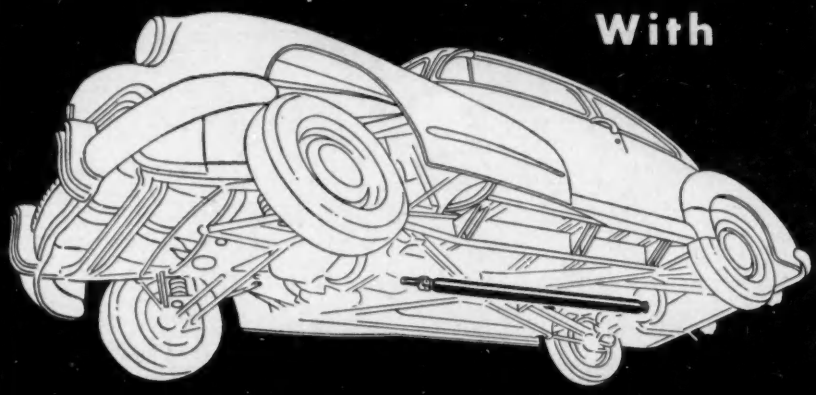

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Applications Received

The applications for membership received between April 10, 1947, and May 10, 1947, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

British Columbia Group: George W. MacAdam.

Buffalo Section: Elliot W. Chapman.

Canadian Section: William Ferrier Allen, P. M. Jackson, John Crawford Martin, Hugh McPherson, Marvin B. Mendelson, Arthur Ernest Russell.

Chicago Section: Walter D. Follis, John Wendell George, Jr., Laurance H. Gillick, Donald Phipps Goddard, Richard S. Graafsma, Edward H. Gustafson, Carl N. House, Miles A. Kinley, Hugh C. Lafferty, Emil F. Moreno, George Paul, Oscar M. Pinsof, Lawrence P. Reilly, Toivo J. Salo, Edward William Schultz, Louis B. Schultz, Loring F. Shoemaker, J. James Shimkus, Val B. Suarez, Harold C. Tellock.

Cincinnati Section: Edward B. Lohaus, Frank A. Tiedge.

Cleveland Section: Fred E. Amon, Jr., J. J. Baadte, John W. Greene, John Michael Pawlechko, Harry Robert Urban.

Dayton Section: F. S. Butcher.

Detroit Section: Martin L. Alspaugh, John H. Austin, Albert Beauchamp, Duane S. Hefty, William F. Heise, Arthur D. Jackson, Theodore R. Jamieson, II, Robert P. Kelly, Miss Eugenia P. Konopka, Clifford M. Manzer, Oscar Oldberg, A. W. Reinhardt, Walter Unterberg, Sterling Joseph Spleet, Paul F. Stibbard, William A. Turunen, Albert F. Vandenbergh.

Hawaii Section: Wallace L. Doty, Ferdinand C. Hons, John F. Maloney, Marshall H. Ownes, Neil Schmitt.

Indiana Section: Robert Lee Cain, E. M. DeCoursey.

Kansas City Section: F. R. Grant.

Metropolitan Section: Frohman Anderson,

Eugene J. Bedell, William G. Bohm, Norman Everett Briggs, Edward V. Cordes, Robert James Foley, Stewart C. Fulton, Frank R. Hormann, Harvey S. King, D. Marshall Klein, Joseph G. Liscouski, Jr., Louis Morda, Robert W. Scott, Guy E. Soper.

Milwaukee Section: Robert Carlin, James Raymond Davis, Kurt Ernst Hohnl, Harry W. Roorda, G. J. Storatz.

Mohawk-Hudson Group: J. F. Cage, Jr.

New England Section: Edward S. Thompson.

Northern California Section: John E. Lindberg, Jr.

Northwest Section: Benjamin P. Bump.

Oregon Section: D. F. Davis.

Peoria Section: James W. Sydnor.

Philadelphia Section: George D. Fraunfelder, James L. Gregg, Robert Donald High, Henry I. Hoot, Isaac M. Sheaffer, Jr.

Salt Lake City: Don P. McStocker.

St. Louis Section: John Thomas Harrington, Ben Nichols, George Harold Watkins.

Southern California Section: Louis A. Borener, Robert A. Bonnet, Harold E. Carlson, Matthias V. Christman, Jack R. Clements, Douglas E. Fahlen, Ivan G. Heady, R. Clyde Jordan, Richard Glover Markham, Ralph S. Newcomer, Robert Q. Parsons, Frank John Pausic, Marion A. Scott, Frank E. Snedecor.

Southern New England Section: Robert C. Duffie.

Spokane Group: Henry C. Tufts.

Twin City Section: Walter H. Clausen, Sidney Howe Crowell, Wayne Byron Johnson, Hugh L. McDermott.

Virginia Group: Burton C. Boesser, M. M. Clements, Winnon Binford Leake, W. G. Raeburn, Harold Y. Rife, Frederick Earl Small.

Washington Section: Louis Earl Clover, Marshall James Corbett, A. F. Notley.

Western Michigan Section: Herbert P. Lindrup, Earl C. St. Amour.

Wichita Section: Herman D. Barnett. Robert G. McKay.

Outside of Section Territory: Charles Theron Grace, LeRoy C. Horpedahl, John M. Kelly, Robert B. Pennington, Harold Edwin Ruppert.

Foreign: H. M. Ainsworth, France; Alfred William Ballinger, England; Hartley Melvin Chaplin, Australia; Fernando Alberto DeOliveria, Portugal; N. Gunnar Karlbom, Sweden; Stanislaw Kozlowski, Brazil; Leslie B. Sweetland, England; William H. Tait, England; Bernard Wilcock, England.

New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between April 10, 1947, and May 10, 1947.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: Ward L. Bennett (M), Richard Garnett Burton (J), Louis T. Gerback (J), Wason M. Hyde (M), James Hamilton Owens, Jr. (M), Allen W. Romig (A), Earle Stewart (M).

British Columbia Group: Wallace S. Fairgrieve (A), W. B. Lovis (A), Alan Bryanton Reid (A), Charles Albert Wood (A).

Buffalo Section: E. R. Broden (A), Julian D. Dickerson (M), Carlysle P. Spiesz (M).

Canadian Section: Pearce C. Armstrong (A), J. Dawson Bunting, Jr. (A), Cedric Hiram Foster (A), Alexander Sydney Gartshore (A), Stuart Grant

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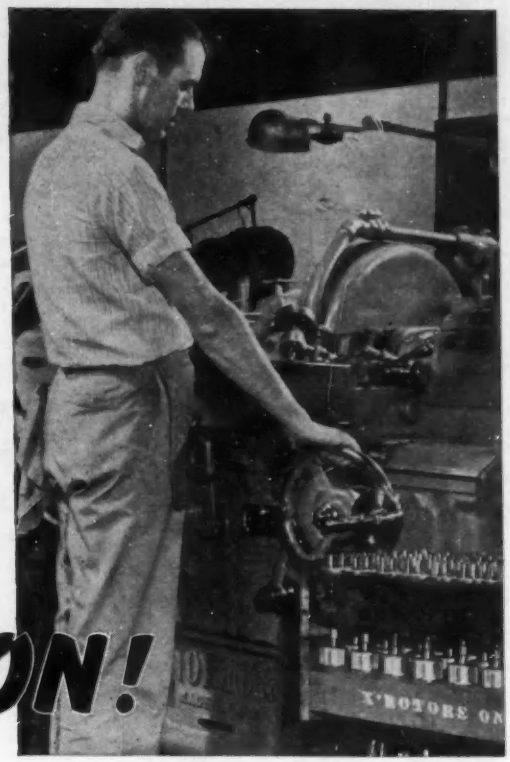

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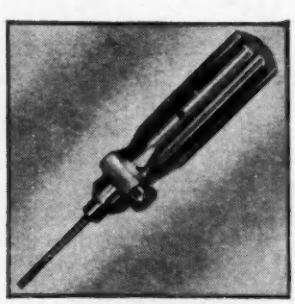

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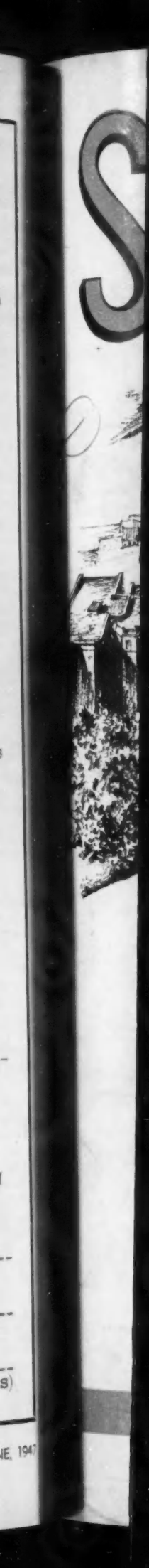
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